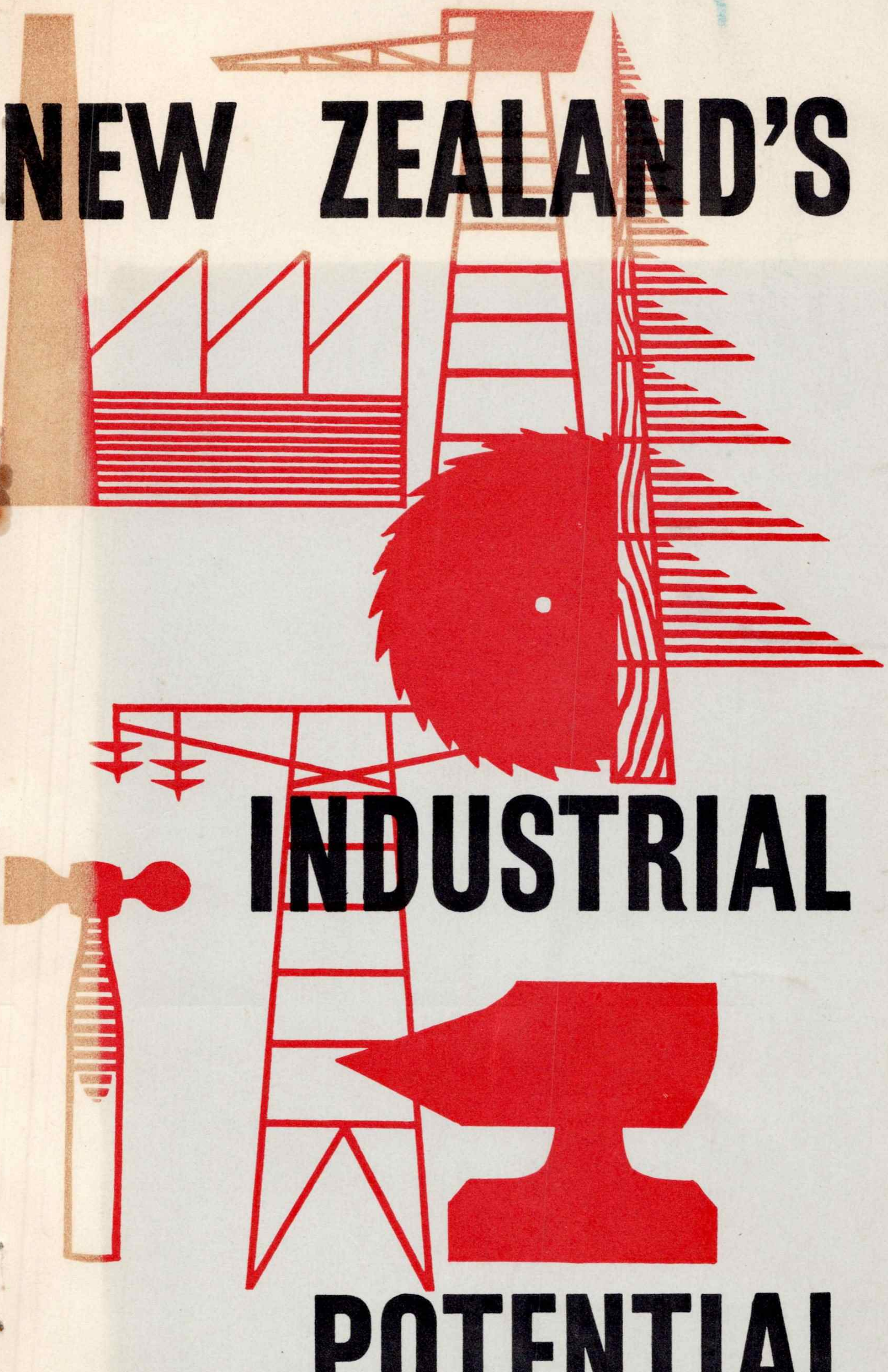
NEW ZEALAND'S INDUSTRIAL POTENTIAL



NEW ZEALAND'S INDUSTRIAL POTENTIAL

Edited by R. Gerard Ward
Marion W. Ward

N.Z.G.S.

CORRIGENDA

Page 3, line 15, for "at depth," read 'at depth),"
Page 5, line 32, for "Hawke" read "Hawk"
Page 7, caption, for "cliff-ride" read "cliff-side"
Page 17, line 34, for "initating" read "initiating"
Page 33, line 44, for "form" read "from"
Page 45, lines 30-31, for "siesmic" read "seismic""
Page 52, line 15, for "about (78(M)." read "about 78 (M)."
Page 60, caption, for "Statistics the" read "Statistics of the"

Page 61, line 6, for "producted" read "produced"
Page 61, Table 4.1. for

Production in Board feet	Number of Mills Total	%	Timber Production Total	%

read

Production in Board feet	Number of Mills Total	%	Timber Production Total ('000 bd. ft.)	%

Page 65, caption, for "Plate VI" read "Plate IV"
Page 74, line 1, reference to footnote 33 after "pastoralist."
Page 91, line 22, for "aluminia" read "alumina"
Page 97, line 10, for "given Table 6.1." read "given in Table 6.1."
Page 159, line 40, for "seasonable" read "seasonal"

New Zealand's Industrial Potential

The 1960 Lectures to

The Auckland Branch

New Zealand Geographical Society (Inc.)

Edited by

R. Gerard Ward
Marion W. Ward

New Zealand's Industrial Potential
Published by the Auckland Branch,
New Zealand Geographical Society, (Inc.)
Miscellaneous Publication No. 3
Branch Publication No. 2.

Printed by The Acme Printing Works Ltd., Auckland, 1960.

ACKNOWLEDGEMENTS

The Editors wish to record their grateful thanks to the 1960 Chairman and Committee of the Auckland Branch, New Zealand Geographical Society; to the contributors; to the following donors of blocks: Lime and Marble, Ltd. (Plates I and II), Shell Oil (N.Z.) Ltd. (Plate III), N.Z. Forest Service (Plate IV), Consolidated Zinc Pty. Ltd. (Plates V, VI and VII), Tasman Pulp and Paper Co. Ltd. (Plate VIII); to Mr. B. H. Farrell for permission to reproduce Figure 2.5; to Mr. Peter Smith and Mr. K. Chapman for the cover design; to Miss Anne Waite for typing the manuscript; to Miss Janice Heyworth for drafting the majority of the maps; to Mr. Peter Mack and other members of the technical staff of the Auckland Regional Planning Authority for cartographic assistance in the eighth paper; to Mr. Owen Smith, the printer; and to Mr. Murray Chapman, Secretary of the Auckland Branch, N.Z.G.S., for his untiring zeal in arranging the lecture course, promoting the publication and advance sales of the book, and in attending to innumerable details associated with its production.

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INTRODUCTION

In 1960 New Zealand's population was 2,356,187 and by 1980 it will have risen to 3,597,000. Over the same period the national labour force will rise from 880,500 to 1,319,000. Between 1926 and 1960 the proportion of New Zealand's labour force employed in primary activities fell from 26 per cent to 16 per cent. If this trend continues only 12.6 per cent of the work force will be engaged in primary industry by 1978. Conversely, secondary industry and the wide range of service industries have employed and will continue to employ an increasing proportion of the labour force.

Other measures of economic activity also show the increased importance of manufacturing in New Zealand. In 1959-60, secondary industry provided 30.6 per cent of the national income compared with 22.6 per cent in 1938-39. Accompanying this accelerating industrial development, there has been a growing national awareness of the need for continued expansion and diversification of manufacturing. With its traditional dependence on primary production New Zealand has always been vulnerable to fluctuations in the price of agricultural products on the European market. The development of international economic unions may increase this vulnerability. In the post-war years Australia's economy has undergone an industrial revolution which has made it possible for that country to absorb over 1,000,000 immigrants in less than 15 years. If New Zealand is to provide employment for its growing work force and maintain a high level of living, a similarly striking expansion of industry must be brought about.

The year 1960, has seen the beginning of a new industrial era in New Zealand. The long preparation through the fostering and growth of the domestic market, the development of skills, the accumulation of capital, and the assessment of the national resources is beginning to bear fruit. Within the year construction has begun on a steel rolling mill and an aluminium fabricating plant; detailed investigation of the ironsands has been speeded up; plans for a cotton mill, a copper mill and an oil refinery have been announced and there is a strong possibility that investigations made during the year will lead to the establishment of an aluminium smelting plant using

some of New Zealand's abundant hydro-electricity potential. These are all industries which are basic to further industrial development.

During 1959, the committee of the Auckland Branch of the New Zealand Geographical Society decided to organize its 1960 lecture programme around the theme of the industrial development of New Zealand. Eight of the lectures have now been assembled in this book under the title "New Zealand's Industrial Potential". The ninth speaker, Mr. A. R. Entrican, Director of Forestry, was prevented by ill-health from preparing a written paper. In its place Murray Chapman and one of the editors have prepared an account of New Zealand's forest resources and forest industries.

The first three papers consider the general industrial requirements of minerals, power and petroleum. They are followed by discussions of specific examples of New Zealand's industrial potential — the development of its forest resources, the establishment of an iron and steel industry, the giant proposed aluminium industry, and the role of the consumer industries. The eighth paper focuses on the impact that present and possible future industrial development has on the leading industrial and population centre of the country. The final paper considers some of the social effects of the establishment of new industries.

Most of the authors are intimately connected with New Zealand's new industries. They are practising specialists in their various fields and as a result they write with authority about the industrial potential which they themselves are helping to turn into reality.

R. GERARD WARD November, 1960.

MARION W. WARD

THE NEW ZEALAND MINERAL SCENE

Gordon J. Williams, Ph.D., B.E.*

The early gold rushes, and the subsequent dredging boom brought great wealth to New Zealand. But as the industry declined, more and more unsoundly based gold enterprises failed, and so the newer generation of New Zealanders not only look upon mineral ventures as highly risky, but they also believe we have no other minerals - they have often been told so by people in high positions. Certainly we cannot expect to find a Broken Hill, but I would judge that we have still to find some metallic minerals in useful quantities. Of less spectacular earthy minerals useful for industrial development we have a relative abundance and variety. This is the sort of mineral which brings continued wealth, rather than the transient riches of a metal mine.

The time is now ripe for new thinking in this direction and for a vigorous approach with a view to sweeping away the prejudices that exist. The development of our minerals is beset with peculiar difficulties, many of them artificial. For example our Mining Act is incomprehensible to all except a few solicitors who have devoted their lives to its complicated provisions; the more interesting mineral areas are progressively becoming inaccessible by successive proclamations of National Parks or "wilderness areas" over unreasonably wide areas; Catchment Boards are making water rights increasingly difficult to obtain; and little encouragement is given to the few good prospectors we have.

There is no united effort, nor indeed is there any considerable effort at all, towards the development of applied research in the direction of mineral discovery, processing, or utilization. This could be done by government agencies, or by other agencies with government support. One may well ask, even if this technological work were pressed forward, would it be used? Our coal industry is still controlled by the "practical man", and for this reason (and also because it suits the unions) technology is allowed to penetrate only very slowly. A further difficulty in developing our minerals lies in the extraordinarily high cost of transport within New Zealand. Some of us used to think that when our population reached 2,000,000, certain industrial minerals would become economic.

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* Dr Williams is Dean of the Faculty of Technology, University of Otago.

We now realize that this population must be in one part of New Zealand, because transport costs tend to be less from abroad than from one end of New Zealand to the other.

All these matters, except the natural location of minerals, are more or less under our control, but in the absence of a strong industry, and with a Mines Department largely stripped of its technological functions by the Department of Scientific and Industrial Research, where is the leadership to come from? We should not be too despondent, for the annual value of our minerals is over £18,000,000 distributed between coal and oil (£7,830,000), metals (£323,000), and non-metallics (£10,200,000). It is not possible to survey in detail this wide range or deal with mineral curiosities in this paper; I can only select certain points of interest, and in so doing attempt to look into the future by considering not only minerals now being produced, but also others which may become of interest[1].

Economically, our minerals fall into several classes. The first consists of those minerals which have long been known but which are nearing exhaustion unless new ore bodies are found or unless market prices rise so as to render it possible to work deposits which are now too low in grade. Gold is our best example of this class of mineral. In the second group fall those minerals of which vast quantities are known to exist in New Zealand but of which the working is, or has been, delayed pending the development of suitable metallurgical techniques. Our ironsands fall into this category. Thirdly, there are those minerals, of the presence of which there is no doubt, but of which the full-scale working must await a growth in our population and in our industrialization. Asbestos is perhaps an example of this, together with certain coals, possibly bauxite, oil shales, raw materials for carbide, titanium white, and many earthy industrial minerals. Finally, there are those minerals of which the existence in New Zealand is now undergoing proof. Of their future we can only speak speculatively at the moment. Oil and uranium fall into this category[2].

GOLD

It is perhaps suitable to begin with the mineral which did so much for our economy in the early days of European settlement. New Zealand made two technological contribu-

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1. Our bauxite and oil possibilities are referred to in other papers in this series. See Williams, pp. 89-106 and Irving and Harvie, pp. 40-55.
2. Many aspects of New Zealand's mineral resources were discussed at the Fourth Triennial Mineral Conference held in the Faculty of Technology, University of Otago, in September 1959. Much of the material in the sequel is gleaned from the "Proceedings" of the Conference.

tions to the gold-mining industry which have since been used in many parts of the world. It was on the Clutha River in Otago that the first gold dredge was devised, and it was on the Hauraki Goldfield that the cyanide process of gold extraction was first applied[3]. Whilst we may be coming very near the end of our alluvial gold (despite the fact that the Teremakau dredge in Westland is doing so well at the present time), we might just allow ourselves to hope that we may some day again have a gold mine. Currently, certain overseas interests are investigating this possibility.

We have had many gold mines, but the main centres of activity have been in the Reefton area in the South Island and on the Hauraki Peninsula, where the outstanding mines are respectively Waiuta (which produced £5,000.000 and may well have at least half this much again at depth, and the famous Waihi Mine (which produced £25,000,000 worth of bullion).

Any prospects for further discoveries on a significant scale are likely to be in either of these areas, with probably the better chance on the Hauraki Goldfield. There, much of the gold-bearing andesite is blanketed with rhyolitic material (Fig. 1.1), and investigations should be directed towards the possibility of another "Waihi" somewhere under this ash. Certainly over the years there has been no lack of effort to discover another by surface prospecting, but as yet the newer techniques of detailed structural geology, geochemistry and geophysics have not been applied. It is a long scientific job and one that I would judge to carry more risk than it is reasonable for private enterprise to attempt, without financial and technological assistance from official sources. Further consideration of extending the known abandoned mines is not a promising avenue of investigation; they are either too deep to reopen (Waiuta) or on Hauraki Goldfields, the gold is too lean in the sulphide zone, and the sulphides themselves too lean to be considered as sources of base metals alone.

New and bold technological thinking is necessary if we want to find gold. Certain other factors could also help. For instance an incentive would be created if the price of gold should ever rise, but this is entirely out of our hands. The South Africans are continually pressing the United States Treasury to devalue gold in terms of currencies. Alternatively it is perhaps possible that our government may some day consider a subsidy on gold. The Australian Government does help its gold industry in this way, although mining engin-

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3. Consideration is now being given to the cyaniding of mill tailings dating from pre-cyanide days, which were released into Ohinemuri River from the early Waihi workings. There is a considerable tonnage of these tailings, now overgrown, at the bends of the river.

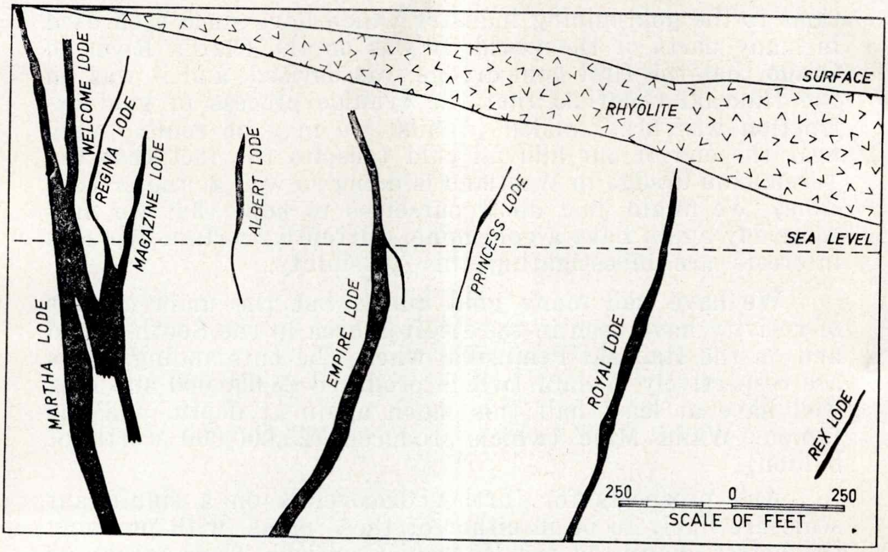

Fig. 1.1. Gold bearing reefs at Waihi, showing masking of reef-bearing ground by rhyolitic rocks. (N.Z. Geol. Surv. Bull. 15)

eers like to think they can find something with a natural rather than an artificial market.

SCHEELITE

Scheelite ($CaWO_4$) has been exported in small quantities from New Zealand for many years. It used to be produced with gold from MacRae's Flat in Otago and from one or two localities in the Marlborough Sounds, but the main centre has always been at Glenorchy at the head of Lake Wakatipu. Enthusiasm for mining this mineral has fluctuated widely in sympathy with its market value. During the Korean War (for Korea is an important producer) it rose in value to about £1 per pound but now it is worth only 4 shillings. Unfortunately it generally occurs very sporadically in thin reefs and so it is unsuitable for big-scale development.

A recent discovery has been made in the remote valley of Canaan in north-west Nelson close to a granite-marble contact. This is just the place where it would be expected, for the marble supplies the lime and the granite the tungsten to form the mineral. Whilst this discovery need not cause excitement, particularly with the present depressed value of the market, nevertheless there are many granite-marble contacts in Nelson, and the pale-coloured scheelite may now be easily distinguished with an ultra-violet lamp from the similar looking minerals that enclose it. We may hope for other discoveries of this mineral. The most desirable form is a

"disseminated" deposit, in which the scheelite is spread through a considerable volume of rock so that it can be mined on a large scale. The sporadic values of narrow reefs are too expensive to find and mine.

MANGANESE

Though we now produce only about 100 tons of manganese ore (the black psilomelane) annually from small prospects around Auckland we used to obtain much more. For instance it was worked on Kawau and Waiheke Islands in the early 1840s over 20 years before gold was discovered in New Zealand. It occurs mainly with the greywacke and occasionally seems to be associated with copper mineralization as on Kawau Island. Characteristically, too, jasper is near at hand, which lends support to the view that the occurrences originate from submarine lavas. All occurrences are small and large-scale development cannot be anticipated. The current production is used mainly in fertilizer manufacturing.

URANIUM

The frantic strategic stockpiling of uranium after the war, and the high price paid for it by governments (about $10 per pound of yellow oxide), led to vigorous prospecting campaigns, and these were so successful that far more was revealed in the world than geologists had thought possible. But to satisfy the demand deposits running as low as 0.1 per cent U_3O_8 have had to be worked. In comparison 15 per cent would be a reasonable figure for lead, 2 per cent for copper, or 0.001 per cent for gold.

Our efforts in New Zealand were originally limited to the prospecting by radiometric means of various stream gravels. Uranium has never been found in significant quantities in stream gravels, and even if it were, it would not be economic to recover it from the refractory minerals of which it would form a part. But in 1955 a weak prospect was found by Cassin and Jacobsen in the Hawke Crag Breccia in the Buller Gorge. This Breccia consists of massive beds of angular or sub-angular fragments of granite and greywacke stripped off rising fault scarps in Cretaceous times. Remnants of it persist on both flanks of the Paparoa Range (Fig. 1.2); north of the Buller Gorge; in the Reefton area; and in two isolated areas in Westland. Similar and roughly contemporaneous beds occur at Naseby and in Taieri Gorge in Otago.

To date some uranium has been found in all the Paparoa occurrences. To the north of the Buller there are several thin horizons in the Breccia that are irregularly radioactive, and over a "mining width" (i.e. the depth of rock that has to be taken out in the course of mining operations) the overall value is probably low by any standard. But more recently

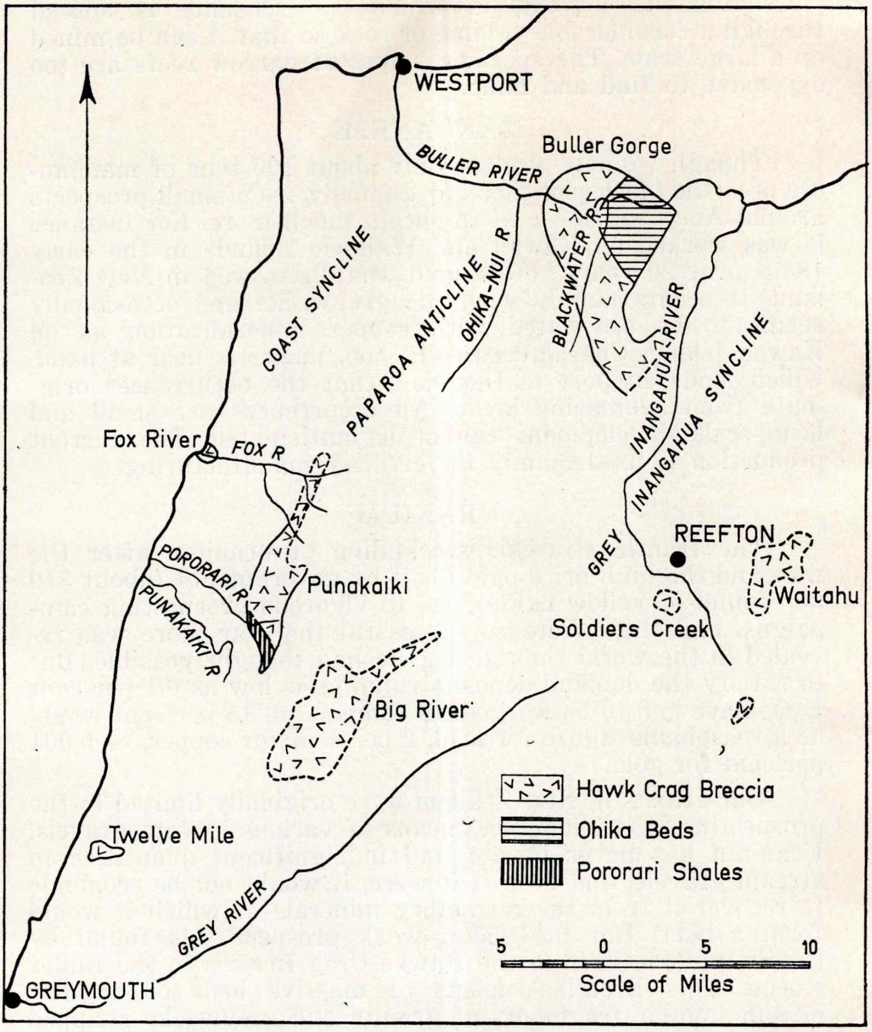

Fig. 1.2. Distribution of remnants of Hawk Crag Breccia, the host-rock to the uranium mineralization. ("Proc. Min. Conf. Otago Univ.," Vol. VI, 1959.)

much richer deposits have been found by private parties (with financial assistance from the Mines Department) south of the Buller Gorge and in the Punakaiki area on the coastal side of the Paparoa Range. (See Plates I and II.) These are generally richer, and being also thicker, overall mining values are higher.

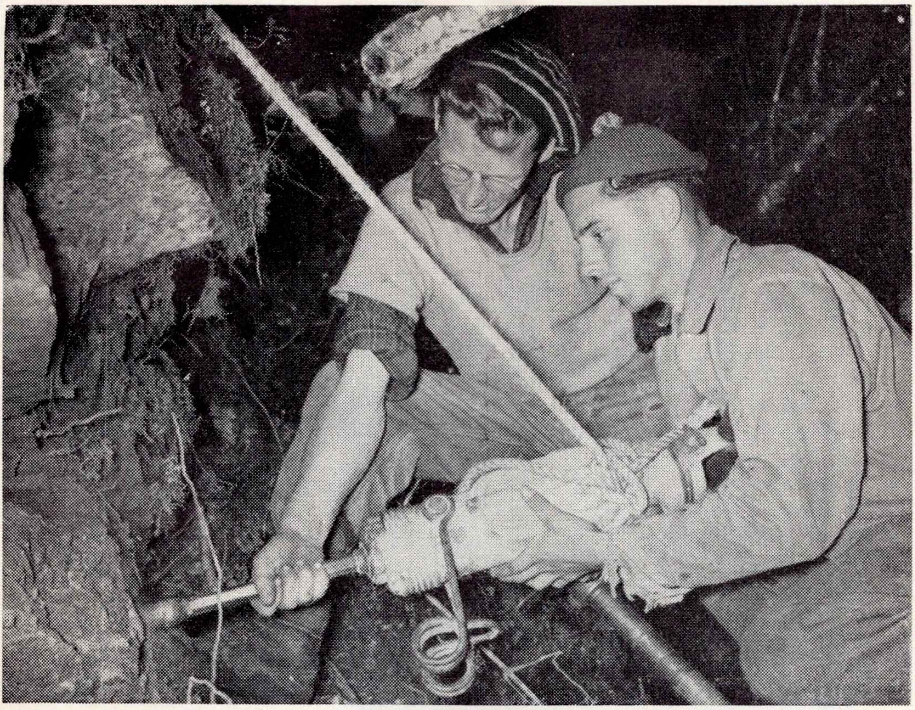

PLATE I. Operating a light portable drill roped to the cliff-ride on a uranium horizon in the Buller Gorge.

At the base of the Hawk Crag Breccia on the Pororari River behind Punakaiki, there is a shale containing bituminous coaly matter. In some places this shale runs 0.2 per cent U_3O_8, but when the coaly matter is removed after crushing, it contains nearly all uranium (say 6 per cent) and when this coal is burnt, the ash contains over 30 per cent U_3O_8, thus opening interesting possibilities for investigation.

The uranium-bearing horizons in the Hawk Crag Breccia are very similar to those of the Colorado Plateau, and are characterised by the mineral coffinite (a hydrous uranium silicate). But in the shale the indefinite carbon-uranium-bearing mineral thucolite has been identified, suggesting a vague genetic similarity to the Witwatersrand gold reefs in South Africa in which gold and uranium tend to occur sympathetically. It may be no coincidence, but rather an expression of a particular type of mineralization, that there is also a little gold in the shales.

We are now at the stage, so often reached in mineral exploration, of making a preliminary assessment. On the one

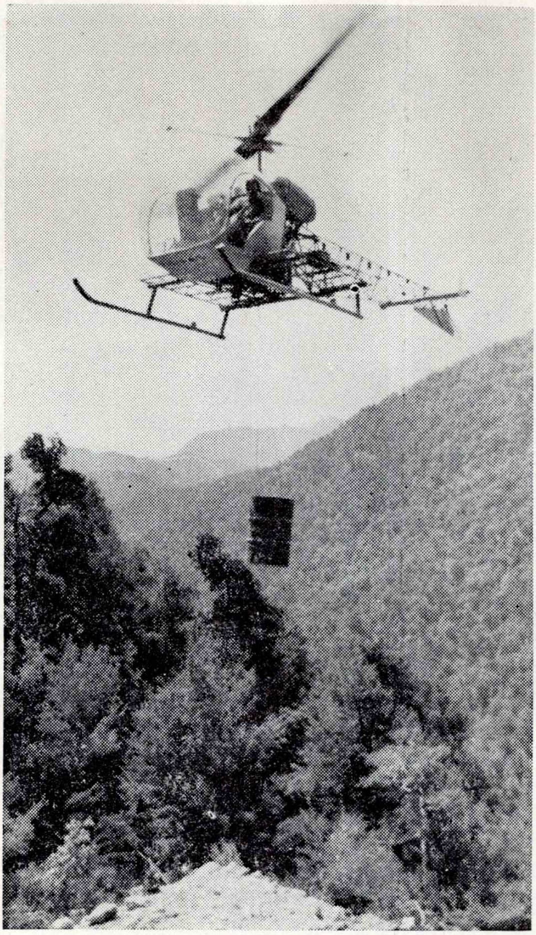

Plate II.
Helicopter air lift to uranium horizons in steep Buller Gorge country.

hand we have what would anywhere be regarded as challenging mineral prospects which suggest that values may be found in excess of those in some operating mines in the world. On the other hand we have to face the fact that the big uranium mining companies will soon have completed their government contracts, their capital will have been amortised, they will have plenty of ore left, and they will be able to go on producing at perhaps $3 per pound. There is certainly no demand at the moment, but although the needs for peaceful uses must steadily grow, it is as yet too early to judge whether this demand will be partly met by the releases from stockpiles and so maintain the market in a depressed condition for some years, or whether there may be a reasonable anticipation for the opening up of new mines on an economic basis. At the

moment it cannot be envisaged that anything but a rich mine could be opened in competition with existing enterprises.

We must therefore gamble on the chances of finding several small but rich mines (I would regard this as a reasonable gamble); upon market expectations(perhaps a doubtful gamble); and on the development of cheaper extraction processes, amenable to small-scale operation (a rather good gamble). Adding all this together and remembering how lack of official encouragement delayed the discovery of uranium until we had missed the strategic market, I consider it most desirable we should do at least enough work to establish in the field and laboratory the distribution of the deposits and their amenability to physical forms of upgrading. This is a risk which would be undertaken willingly by most governments.

IRONSANDS

Our ironsands have remained a challenge since the early days of settlement; to the layman, they seem just too easy! Attempts to smelt them in Taranaki date back to 1848 but still the sands remain untouched. The black ferruginous minerals of these sands are more varied than at first appears, for they consist of three separate minerals: magnetite, Fe_3O_4, (over 70 per cent Fe); titanomagnetite, Fe_3O_4. TiO_2 (50-58 per cent Fe, 7-9 per cent TiO_2); and ilmenite, FeO. TiO_2 (32.5 per cent Fe, 45 per cent TiO_2.)

The beach and dune concentrations have been formed by wave action generated by the prevailing westerlies on the debris from volcanic rocks brought down by the rivers in the North Island, and from a varied suite of rocks in the South Island. The lighter material is drawn back into the sea, leaving a relative concentration of the heavy iron-bearing minerals on the beaches, and in wind-blown dunes for varying distances inland.

It is only in the last decade, through the work of the Department of Scientific and Industrial Research, that we have come to know just how these minerals are distributed.

TABLE 1.1

PERCENTAGE OF MINERALS IN NATURAL SAND AND RECOVERABLE TONNAGES

Coastline	Magnetite	Titanomagnetite	Ilmenite
Western Auckland	-	23% 545,000,000	7% 8,600,000
Taranaki	-	say, 30% average 756,000,000	-
South Island *	say, 0.4% 220,000	-	5.5 % 3,000,000

* Carters and Nine Mile Beaches near Westport only. There are also vast quantities on the less accessible beaches further south.

Apart from small occurrences elsewhere, the main deposits are all along the western beaches of both islands. They have not been fully investigated, particularly below water level, but the above figures for the three most interesting lengths of coastline may be regarded as conservative and roughly comparable. (See Fig. 1.3.)

In considering the economic potential of these sands, several possibilities present themselves. The first is the establishment of an iron and steel industry. Clearly the Taranaki sands are the most advantageous for this purpose, because they contain the highest content of iron, and it is this project upon which attention is currently focused. Secondly, a titanium oxide ("titanium white") industry might be established. We imported £660,000 worth of this substance in 1958, mainly for the paint industry, and we could possibly use the ilmenite of either the Auckland or the Westport beaches, after removing the titano-magnetite, magnetite, and other siliceous minerals. Our ilmenites have the advantage of being low in chromium (a discolouring impurity), but they are also low in titania, which means there is more iron, and consequently a high usage of acid in processing unless the chlorination process is used. The ilmenites which are richest in TiO_2 are from tropical countries where temperatures are such as to cause the iron to be differentially leached by solution in the course of geological time. Thirdly, we could consider an iron and steel industry with titanium by-products. For this the Taranaki sands are probably the most desirable, but metallurgists would have to produce slags richer in titania than I believe they have yet done; the titanium enters the slag, which can then be treated for its recovery.

It might be argued that as these sands have been known for a long time, and are manifestly present in huge quantities and in a very rich condition, why have the big steel companies not come here? These sands are nearer Newcastle, New South Wales than is the Yampi Sound ore now used there. And as the companies have not come, are we presuming to be wiser than they with all their "know how"? It is certainly not that we may be unable to find cheap sources of steel overseas from India and Australia, or that we need be apprehensive of the continuation of these sources of supply, or that we have insufficient ore. Is it because we have only just become big enough as a country to have an iron and steel industry? Is it that new metallurgical processes have been developed of particular significance to the working of titaniferous ironsands, or of such a kind that a relatively small industry can be economic? Or have we at last spare hydro-electricity? Our future cannot lie in cheap large-scale blast-furnace operation because our ore is in sand form, it is titaniferous, and our

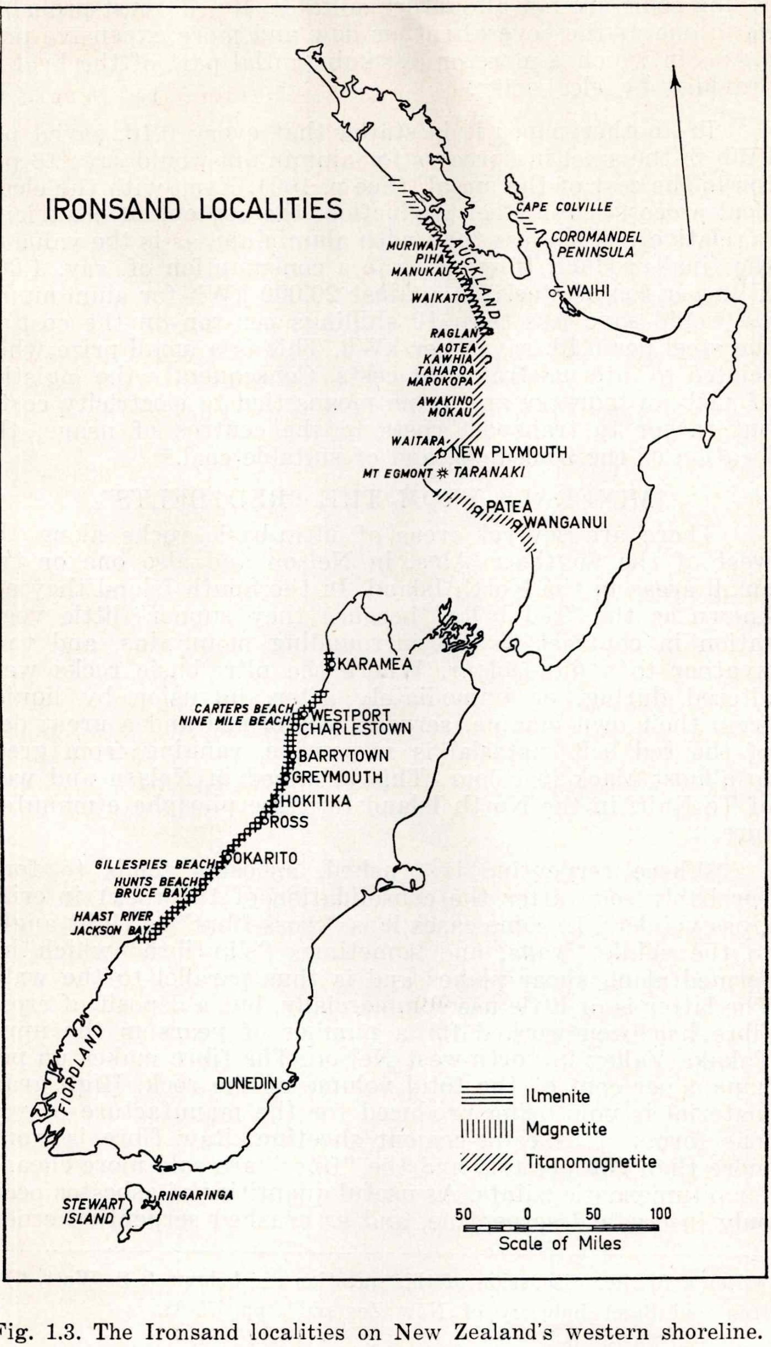

Fig. 1.3. The Ironsand localities on New Zealand's western shoreline.

coking coals are not altogether suitable. It will most probably lie in one of the several rather new and more expensive processes in which a more or less substantial part of the heat is provided by electricity.

In another paper it is stated that every 0.1d. saved per kWh in the smelting process for aluminium would save £8 per ton in the cost of the metal. (See p. 100). Even with the electrical processes for steel production, the content of electricity is relatively much less than with aluminium, as is the value of the final product. If we assume a consumption of, say, 1,000 kWh per ton of steel (as against 20,000 kWh for aluminium) we would save less than 10 shillings per ton on the cost of the steel per 0.1d. saved per kWh. This is a small prize when related to internal transport costs. Consequently the logistics of such an industry are by no means tied to electricity costs, but rather to transport costs to the centres of usage, the location of the ironsands, and of suitable coal.*

MINERALS FROM THE "RED BELTS"

There are several areas of ultra-basic rocks along the west of the Southern Alps, in Nelson and also one or two small areas in the North Island. In the South Island they are known as the "red belts" because they support little vegetation in contrast to the surrounding mountains, and they weather to a dun colour. Where the ultra-basic rocks were altered during, or immediately after, intrusion by liquids from their own magma, serpentines formed and a great deal of the red belt material is serpentine, ranging from green to almost black in colour. This is mined in Nelson and west of Te Kuiti in the North Island for superphosphate manufacture.

Where serpentine is crushed, asbestos tends to form (probably soon after the consolidation of the rock) in criss-cross veinlets. In some cases it is "cross-fibre" at right angles to the veinlet walls, and sometimes "slip-fibre" which has formed along shear planes and is thus parallel to the walls. The latter is of little use commercially, but a deposit of cross-fibre has been worked for a number of years in the upper Takaka Valley in north-west Nelson. The fibre makes up perhaps 4 per cent of the total volume of the rock. High grade material is now being produced for the manufacture of various forms of asbestos-cement sheeting. Raw fibre is worth more than £50 per ton, and the "fines" are sold more cheaply for bitumenastic paints. As useful quantities of asbestos occur only in crushed serpentine, and as crushed serpentine erodes

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* For a further discussion of this question see below: J. S. Watt, "The Iron and Steel Industry of New Zealand", pp. 75-88.

readily, outcrops are unspectacular and tend to occupy lower ground. We should have another look over our red belts with this point in mind.

In the Takaka Valley also we are already mining deposits of a composite talc-magnesite rock. The magnesite from it is used for correcting the magnesium deficiency on certain lands in Nelson. A proposal is afoot, however, to separate these minerals by the flotation process and dispose of each separately. The talc might be used in the rubber industry, as a filler, and for paints and insecticides. The magnesite would be for special refractory products. The quantities of raw material available are very large, and it is noteworthy that Australia imports magnesite.

There are extensive areas of ultra-basic rocks in New Caledonia where they have been deeply weathered during tropical pluvial periods in the past, and the dispersed nickel, cobalt, and iron have tended to be concentrated, each in its own zone in the deep-weathered profile. We cannot hope to find recently formed concentrations in New Zealand because of our colder climate; and because our ultra-basic rocks are mainly in steep, mountain country subject to heavy erosion, there is not much likelihood of fossil concentrations remaining from the warmer Pliocene times.

It is interesting to note that the red belts also provide New Zealand's traditional mineral, greenstone. Only the hardest greenstones can withstand the rough-and-tumble of the swift flowing West Coast rivers and consequently the best is obtainable from the dredge tailings. This is at best an uncertain source of supply. Owing to the habit of its occurrence, greenstone is not likely to occur in situ in more than sporadic pockets, and consequently our chances of mining quantities are but slight. Perhaps this is a good thing, for no one would like to see our native greenstone reduced to a common market product.

THERMAL WATER

It may be thought that it is stretching things too far to include water in this paper! But the thermal waters that rise from cooling magmas beneath the surface may correctly be regarded as mineral materials. We can actually see them forming a mineral deposit at Ngawha in Northland, where the bright red mineral cinnabar occurs in the sinter crusts of the hot springs. This and other Northland deposits of mercury are worked occasionally, but there is no promise of a continuing industry unless someone can find a disseminated occurrence which could be opencast. One half of one per cent of mercury spread through ash beds would be visually unobtrusive but very interesting economically.

By the above definition, the steam which is now exploited as a source of power at Wairakei is only partly mineral, for much of it is undoubtedly rainwater that has seeped through the heated strata. However, the magmatic waters which mix with the meteoric waters contain some interesting substances in surprising amounts. For instance, S. H. Wilson of the Institute of Nuclear Sciences has found that the surprising quantities of salts listed in Table 1.2 are currently being discharged with the steam every year.

TABLE 1.2
ANNUAL MINERAL CONTENT OF WAIRAKEI STEAM

	Tons	Value
Sodium chloride	159,400	£797,000
Potassium chloride	18,000	£540,000
Sodium sulphate	2,870	
Sodium fluoride	870	
Calcium carbonate	1,860	
Lithium chloride	4,230	£3,300,000
Rubidium chloride	200	£470,000
Caesium chloride	144	
Boric acid	7,640	£235,000
Silica	20,000	
Arsenious oxide	330	£13,000

No one, let alone Mr. Wilson, would be so naive as to pretend that this £5,000,000 is immediately recoverable. Although the value of lithium alone exceeds the value of the power generated it should not be concluded that this value is callously wasted, for the problem is to find some way of getting it out without using up all the power produced. If we did get it out, we might flood the world lithium market and so reduce its value to something quite low by present standards. In the meantime it is prudent to endeavour to devise chemical engineering techniques so that we will be prepared for potential markets.

So we may note that our thermal waters are responsible for such diverse mineral substances as diatomite (see page 18), mercury, and the lithium, caesium and rubidium elements.

COAL

Coal still supplies about 30 per cent of our energy requirements despite the inroads of oil into some traditional markets and more ready availability of hydro-electricity in the past decade. We are a very long way from being able to do without coal although we have no large basic industry dependent upon it except the new Maramarua coal-fired electricity generating station. Yet the consumption of coal is not declining : it is static.

Perhaps we may anticipate that population increase, the establishment of new coal-using industries, and the development of certain existing industries, may balance further losses in traditional markets. The usage pattern for 1958 is given in Table 1.3.

TABLE 1.3

NEW ZEALAND COAL CONSUMPTION

	Tons Consumed	Percentage of Total
Domestic	897,000	34
Dairy	312,000	12
Railways	269,000	10
Gas	256,000	10
Lime and Cement	184,000	7
Freezing	158,000	6
Electricity	154,000	6
Shipping	28,000	1
Other industries	363,000	14
	2,621,000	100

We are not short of coal, as has often been said; we have immense reserves in relation to our annual and prospective usage. Recent estimates in millions of tons are given in Table 1.4.

TABLE 1.4

NEW ZEALAND COAL RESERVES IN MILLIONS OF TONS

Type of Coal	Measured	Indicated	Inferred
Bituminous	40	33	51
Sub-Bituminous	106	126	307
Lignite	16	42	310
	162	201	668

Unfortunately the relative proportions of the different ranks of coal, their situation in relation to industries that need them, and their qualities are not just as we would wish. For instance the bar harbours of the West Coast preclude the export (except by trans-shipment) of Paparoa coal, the only coal we could sell readily overseas. The high sulphur content of our Westport bituminous coals renders them unsuitable for gas-making and for the manufacture of metallurgical coke, and we have virtually no anthracite. We are further faced with the difficulty that our coal miners rather naturally resist having to move to new centres of mining, because in doing so they would have to abandon their homes which represent their life savings.

The industry has shown little resiliency in technological development, and has shrunk from boldness in planning. For instance, if we cared to do so, we could expand the proportion of opencast coal, and we could greatly develop hydraulic coal mining in certain areas. The latter is a

New Zealand invention, brought about by the ingenuity of our gold miners in adapting the principles of hydraulic gold mining to coal, either opencaast or underground. The water may be used through jets to break down the coal (generally lightly blasted beforehand), or merely to move it in flumes to bins on road or rail routes. Both of these methods, combined with conventional mining, could substantially reduce the average cost of coal in New Zealand. But under these methods the work is done by power-shovels or by the water, rather than by men, and so human problems related to the certainty of employment arise.

The Geological Survey has shown that the rank of a coal depends largely upon the depth to which it has been buried. For instance the lignites at Charleston on the West Coast are the same beds as are the bituminous coals on the Denniston Plateau 20 miles to the north, but were never buried so deeply under later sediments. With such a highly complex tectonic Tertiary history as we have had, it is obvious why we have such a diversity of coals. Similarly rapid variations of rank occur over the Greymouth coalfield. Whilst New Zealand coals generally have a higher hydrogen content than British and American coals (reflected in a higher volatile content), some coals in the Greymouth coalfield (e.g. Paparoa Mine) have quite unique volatile contents which result in exceptional swelling properties when coked. Coal of this quality would be regarded as a much sought-after asset overseas where it would be used for the manufacture of metallurgical coke. It is this coal that has attracted Japanese attention as noted periodically in our newspapers. Its exceptional quality might compensate transportation costs, but I am inclined to wonder, with our growing industrial expansion, whether we should seek the immediate gain of exporting it overseas, rather than the longer-range advantage of retaining it for our own use.

Many schemes have been put forward for the fuller use of our coal resources, ranging from low and high-temperature carbonization with all their varied by-products, to other schemes in which the power used is shared in varying proportions with hydro-electricity. An example of the latter is carbide manufacture. Dr. Hagyard of the University of Canterbury has suggested that such an industry on a modest scale might cost £1,750,000, and produce products worth £1,300,000 per annum. The products would range from calcium carbide for export, to acetylene for New Zealand consumption, calcium cyanamid for fertilizer, and polyvinyl chloride for plastics. The raw materials are coal (21,000 tons per annum), limestone (40,000 tons), salt (3,000 tons), and cheap electric power. It would seem that this should be closely looked into in the South Island, because of the ready availability of electric

power. A survey of raw materials is also needed, the specifications for these being highly selective[4].

The Makaraeo limestone at Dunback in Otago readily fulfils these specifications and yet it is being used for cement manufacture. The Takaka marble in Nelson is also suitable.

Another possibility lies in using coals for the production of carbon articles such as furnace carbons of which we import £137,000 worth every year. Electricity also enters into this process to a considerable degree[5].

OIL SHALES

In another paper in this series, the occurrence of natural oil is dealt with[6]. Here, I should like to draw attention to our oil shale. This is a soft greyish or brownish sediment giving a characteristic dull sound when struck. It contains no oil as such but yields oil when distilled. The organic material is derived mainly from vegetable matter, and not from marine life as with natural oil.

Technological advances are bringing closer the possibility of working the huge shale deposits that partly fill the upper Nevis Valley in Central Otago. These deposits are remarkably uniform in grade and are largely amenable to opencast operation, They may contain 2,000,000,000 tons of shale, and a yield of about 12 gallons of oil per ton has been suggested. Leaving aside the distribution of grades that go to make up the mineral-oil requirements of a country, this represents our annual national consumption, at present rates, for 50 years. It is tempting to think of this, but we must remember that there are very few economic plants for the distillation of oil from shale in the world. Those plants which are working are using shale with a very high yield, or they enjoy some form of government protection, or they are able to use their spent shale in some other way (as, for example, for cement manufacture). Neither the first nor the third of these factors could pertain here nor is there the possibility of distilling the oil without mining the shale by initating a distillation process on the shale in situ beneath an impervious cover as is done in Sweden. Our shales have practically no cover at all. We should not forget the possibilities of these shales in a rapidly developing technological world, but our hopes should be modest.

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4. For instance, P_2O_5 and sulphur in the limestones must be less than 0.002 per cent, and 0.1 per cent respectively.

5. The possibility of producing anodes for aluminium smelting is mentioned in another paper in this series. (See p. 89).

6. See J. S. Irving and A. M. Harvie, "The Petroleum Industry of New Zealand", pp. 40-55.

MINERALS FOR THE CONSTRUCTION INDUSTRY

Of these, the minerals that go into cement manufacture are of course the most important. Over much of New Zealand, these materials are fairly abundant, but their situation in relation to that of the coal for firing, and to the main markets involves considerable economic study, and with each of our six cement plants some compromise has had to be made. The raw materials are limestone and marl. In some plants silica has to be added in the form of sand to correct the ratio, and in others some iron ore is added.

The Dunedin plant is south of the centre of gravity of its markets, and it is also some distance from coal and from lime (although it is possible a local calcareous sandstone could be upgraded by mineral benefication processes, at a cost less than the freight on lime now used). The Westport plant is remote from all significant markets, but the limestone, marl and coal are at hand. The Golden Bay plant is remote both from markets and from coal, but this disadvantage is offset by bulk-shipping in a specially designed vessel. The Northland plant is north of the centre of gravity of its main market, further north still from its coal, and the limestone (only 72 per cent $CaCO_3$) has to be upgraded by the flotation process. (This is the only flotation plant operating in New Zealand. although it is possible another may be installed in Nelson to separate the talc and magnesite from a quartz-talc-magnesite rock.) At present the capacity of the cement industry exceeds demand, and a certain amount of poaching is going on in the traditional markets of one company or another.

While dealing with cement, mention should be made of pozzolan. Originally this material, in the form of volcanic ash, was used by the Romans at Pozzuoli and elsewhere as a substitute for sand in lime mortar to produce a cement that will harden under water and gain resistance with age. Pozzolans used with cement give the advantage of a reduction in the amount of cement used, of expansion when reactive aggregates are used, of heat generated from the hydration of the cement, and of segregation in fresh concrete, together with increased resistance to chemical attack. Pozzolans are added to the extent of 10-20 per cent of the total cementing material. Other materials are either pumicite or diatomite, and both have been used, the former (in natural form from Takanini) by the Auckland Metropolitan Drainage Board on the Manukau scheme, and the latter (from Whirinaki near Rotorua) on Waikato hydro-electric projects.

Diatomite is of course the name of a light rock formed almost exclusively of the siliceous tests of diatoms which

exist in abundance in colder sea waters, and also thrive in lakes where the waters are enriched with silica from volcanic sources. Both the Whirinaki deposit and another deposit near Middlemarch in Otago were formed in this kind of environment. Diatomite has many other uses, for example, as a filter aid or as a polishing medium, for insulation and in paper products. Considerable research is necessary to explore the adaptability of New Zealand materials to different needs.

We should not leave the cement field without mentioning the aggregates that go with cement to make concrete, particularly lighter-weight aggregates which improve insulation properties, and, because of the lower overall weight of a structure, effect savings in the quantity of steel needed for reinforcement. Auckland already has a natural medium-weight aggregate in the form of scoria, and recent experiments have shown that argillite from Petone, when heated to the extent of forming a fused surface skin over the lumps, is also satisfactory as a medium-weight aggregate, although it is not yet commercially produced.

Commercial production of a light-weight aggregate began in 1955. Perlite, a natural volcanic material which is quarried near Kinleith, is the raw material. In its natural dense form it is shipped to various points in New Zealand, there to be heated at from 1500° to 2000° F, when it swells rapidly into a white foam-like material, the specific gravity being reduced in the process from 2.4 to as low as 0.05! Concretes containing perlite may weigh from 20-50 lbs per cubic foot and will float on water. Such material is used mainly for insulating floors, roofs, and freezing chambers, and it is claimed that expanded perlite may also be added to plaster wallboards, reducing the weight by 30 per cent, and the cost by 20 per cent.

CLAYS

It is noted in another paper in this series that bauxite has formed on old basalt surfaces in Northland and that this bauxite contains up to 57 per cent alumina. Under less prolonged or cooler weathering conditions clays have formed and some of them are used by the ceramic industry. They contain only 20-30 per cent alumina. Because the weathering process has not gone so far with ceramic clays the chemical composition of the parent rock has been less masked, and the clays vary widely in quality and are almost as diverse as their parents.

As with bauxites, many clays do not owe their origin to the present weathering cycle, but to weathering cycles in the past when more advanced alteration was effected under warm climatic conditions during parts of the Tertiary era. For instance the greywacke surface under the Tertiary sequence in the Benhar area of Otago has been so completely weathered as to constitute a valuable clay. Also at Mt. Somers in Canterbury, an early Tertiary deeply weathered surface of rhyolite produces china clay which is widely used in the whitewares industry. More widely exposed, because there has been less time for later sediments to be superimposed, are clays belonging to the relatively warm Pliocene times. This latter weathering cycle, which has provided raw material for the ceramic industry in some places, also provides problems for our engineers. The deeply weathered gabbro at Bluff, for example, created problems in establishing the foundations of the new harbour works, and the greywackes of the Waikato area are generally so weathered as to be useless for road metal.

Some clays represent the alteration of rocks by rising magmatic solutions as in the Wairakei area and in the gold province of Hauraki, but generally clays derived from volcanic rocks in the North Island, either by hydrothermal or surface weathering are poor in quality. Other ceramic clays are "transported" and occur as sediments removed from their parent rock. Typical of these are the clays that are interbedded with some coal measures. On the Waikato coalfield they are used for making refractory and building bricks, and those from Kakahu in Canterbury are ball-clays which find a wide use in our ceramic industry. A further group of clays has been formed, particularly in Canterbury, Otago and Southland, from the loess blown from the Southern Alps during the Pleistocene ice age. In places these have been used for making bricks and pipes, but their grain-size and colour are not suited for more delicate wares. Our ceramic industry is a thriving one producing £2,400,000 worth of goods each year, including field tiles, bricks, sewer pipes, insulators, sanitary ware, fine china, and refractory bricks. For all but the commoner products, clays from various localities are blended.

Bentonite is an interesting clay that finds no place in the ceramic industry. It is characterized by exceptionally fine grain size (10.000,000,000,000 to 1 cubic inch) and a high degree of swelling when heated. It is derived from ash showers which settled in the Tertiary seas along the eastern side of the North Island. Its colour is usually greyish or bluish. Bentonite is responsible for unstable ground in many

areas, and industrially it is used in deep drilling for oil or geothermal steam, and as a bonding agent in foundry sands.

It becomes clear, therefore, that New Zealand's mineral resources are much more varied and may provide a base for a much wider range of industries than is often supposed. Many of the minerals are unspectacular, some are of doubtful economic value, but others are essential for the country's future industrial development.

POWER RESOURCES OF NEW ZEALAND

C. M. Gray, M.I.E.E., M.N.Z.I.E.*

Discussion of New Zealand's power resources is purely academic unless we first estimate our requirements. If these are small, and the resources awaiting development obviously very large in comparison, any accurate assessment of the total resources is unnecessary. On the other hand, if we need very large quantities of power and are doubtful if the resources are available to provide them, we must take stock of our resources to see how our demand can be met. The two pertinent questions to be answered are, how much power do we need, and where is it to come from? These two questions and their answers provide the theme for this paper[1].

POWER REQUIREMENTS

The estimation of power requirements involves a good deal of intelligent guesswork, and we can only guess near the mark if we study the history of electrical development in New Zealand.

The first public supply of electricity in New Zealand was begun in Reefton in 1887. The story is that one Walter Prince arrived in the town at the height of the gold-mining boom, bringing with him a 1 kilowatt direct current generator which he is reported to have made himself. After suitably indoctrinating a group of mining speculators, he gave a demonstration of this new kind of light. The generator was driven from a steam engine in the local brewery and underground conductors laid to Dawsons Hotel, where several lights were

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1. The following technical terms are used in this paper:

KILOWATT (kW): Unit of electrical power equivalent to about 1-1/3 horse power.

MEGAWATT (MW): 1,000 kilowatts.

KILOWATT HOUR (kWh): Units of electrical energy, usually called a "unit".

CUSEC: One cubic foot per second - measurement of water flow

installed. The spectators continually passed to and fro between the brewery to see what made the light, and the hotel to see the light itself. The outcome was the formation of a public company, the "Reefton Electrical Transmission of Power & Lighting Company", which, in due course, harnessed the waters of the Inangahua River; and so, the public supply of electrical energy in this land was born.

For many years electricity supply was confined to the larger cities and boroughs. Power was generated by water, steam, gas and oil engines, and it was used almost solely for lighting and small motors. In 1903, the Water Power Act was passed, reserving for the Crown the sole right to use the country's water power. By 1910, the government of the day was beginning to take an interest in the exploitation of water resources, and two government officers, R. W. Holmes and Lawrence Birks, reported on the expectation of demand for power and on some possible hydro-electric schemes. An interesting section of Birks' 1910 report refers to "the use of the surplus power for the manufacture of nitrate fertilizers, calcium-carbide, aluminium and for other electro-chemical industries." Mr. Birks would, no doubt, be glad to learn that 50 years later, the government had made some progress in adopting his proposals.

It was not until the passing of the Electric Power-Boards Act in 1918 that any real impetus was given to making electric power available to the country as a whole. This Act made provision for the constitution of special local bodies charged with the duty of distributing electric power throughout a given area. The Act envisaged an Electric Power District as a combination of urban and rural territory so that the dense loading of the towns would assist to make economic the reticulation of the country districts.

The growth of electrical supply since the passing of that Act is shown in Table 2.1.

TABLE 2.1

Year	kWh Generated (millions)	Year	kWh Generated (millions)
1920	150	1942	2,000
1922	200	1944	2,300
1924	250	1946	2,500
1926	450	1948	2,800
1928	600	1950	3,035
1930	750	1952	3,462
1932	830	1954	4,629
1934	930	1956	4,675
1936	1,100	1958	5,644
1938	1,400	1960	6,550
1940	1,800		

An examination of the growth of electricity consumption in the past provides a basis for estimating future needs.

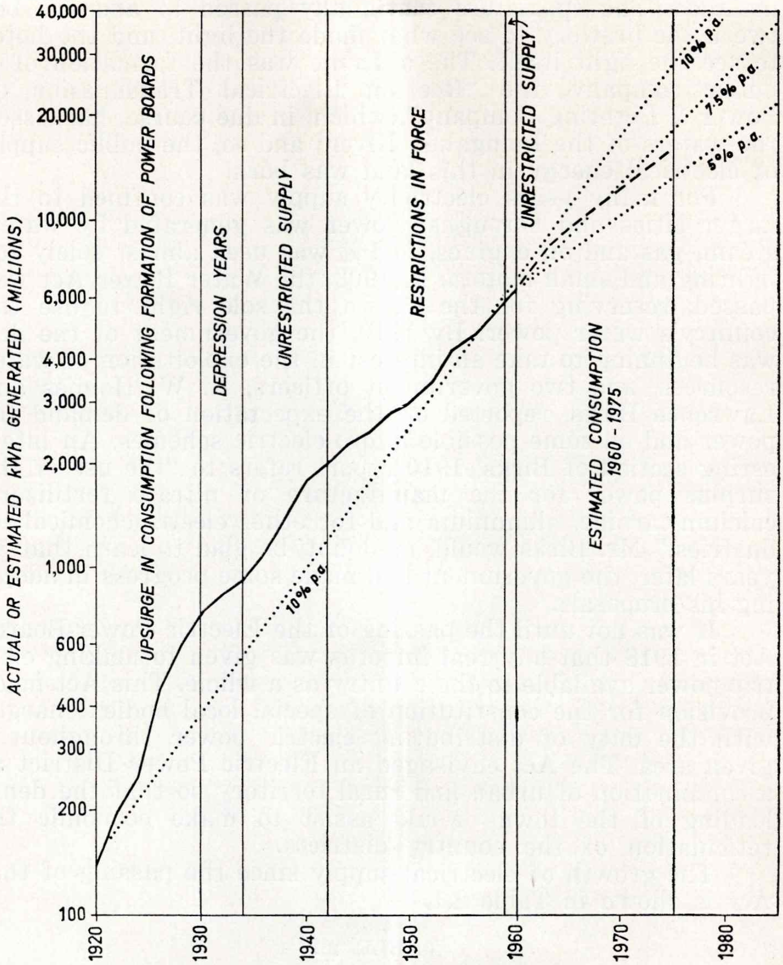


Fig. 2.1. Annual power consumption 1920-60 and estimated consumption to 1975.

Figure 2.1 reproduces the graph of the load growth shown in Table 2.1, but extrapolates it to the year 1975, giving an estimate for the next 15 years. The average rate of growth from 1920 to 1960 is at the compound interest rate of 9.8 per cent. It is assumed that this rate, between 1960 and 1970, will fall to 7.5 per cent and from 1970 to 1975 to 6 per cent per annum.

Figure 2.1 is constructed on semi-logarithmic paper and thus shows the compound interest curve as a straight line. The rates of 10 per cent from the origin and 5 and 7.5 per

cent from the 1960 value are shown, and indicate these values relative to the estimated curve. There are many who believe that this estimate is too low, and that the increase could well continue closer to the 10 per cent curve. This is unlikely, since unless there is an increase in population far greater than that now estimated by the statisticians, the resulting consumption per capita leads to figures which are unrealistic, considered in the light of our climate and way of life.

It is, therefore, assumed in this paper that the requirements of the next 15 years will conform within reasonable limits to the graph in Figure 2.1. Estimates are confined to a 15 year period as over a longer term they become too speculative, because so many of the assumptions that have to be made are outside our control. International relationships, government policy on such matters as immigration, import control and secondary industry can have a marked long-term effect. The estimating period must, therefore, be not so long that a departure from present-day conditions would produce a widely different result at the end of the period. This means, of course, that estimates must be reviewed year by year, so that the effect of any change in policy or conditions can be predicted with reasonable accuracy for 15 years ahead.

At this stage, it is informative to examine the load growth of other countries. The rates of load growth in a group of countries, having a similar degree of electrical development to New Zealand are shown in Figure 2.2. The significant features are the similarity in shape and slope of the curves, and the fact that the slope does not seem to be affected by whether the demand for electricity is predominantly industrial or domestic. For example, in the United Kingdom, about 60 per cent of the load is industrial and about 30 per cent domestic. In New Zealand, the converse is true - yet the slope of both curves is markedly similar.

If the estimates in Figures 2.1 are taken as the basis of requirements, these figures of kWh consumption can be translated into the capacity of generating plant required to provide these units. Table 2.2 makes this conversion.

TABLE 2.2

Winter of	Peak Load in MW	Planned Generating Capacity
1960	1310	1345
1965	1872	2028
1970	2547	*
1975	3270	*

* No firm plan for this period.

Thus, if the power station building programme adheres to the scheduled dates, in 1960 there will be a surplus of plant over demand of 35 MW; in 1965, of 156 MW; while, after 1965 (so far as the North Island is concerned), no definite an-

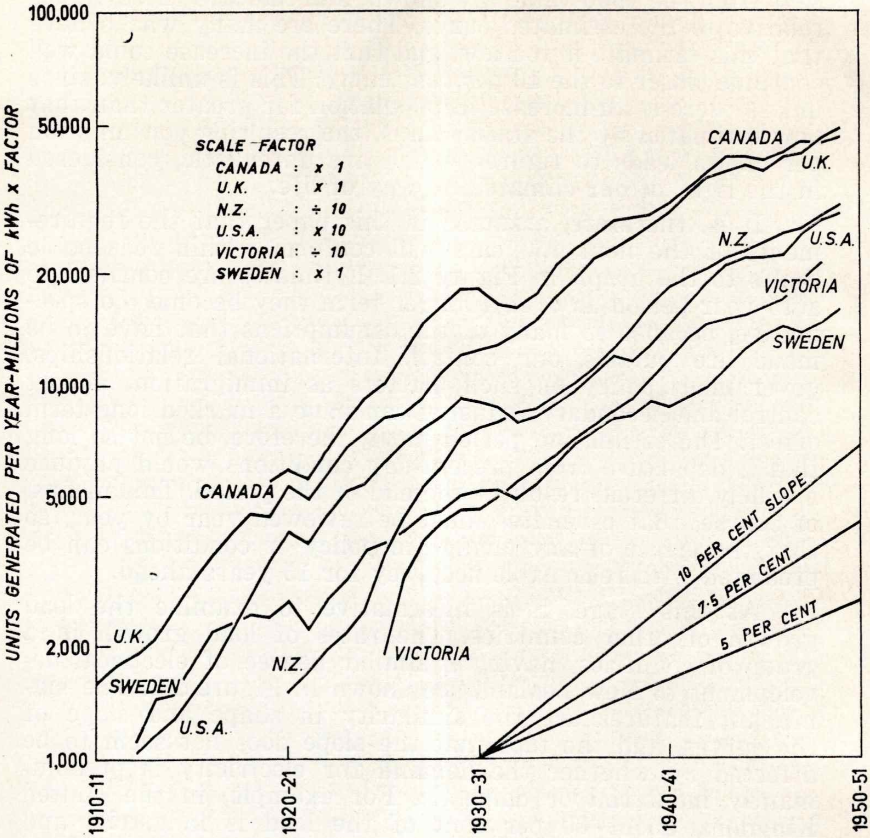


Fig. 2.2. Load growth in selected countries

nouncement has been made as to where the power is to come from. The important fact which emerges is that, between 1965 and 1970, there must be added to the generating system, new plant with a capacity of 519 MW at the rate of 100 MW per annum. Between 1970 and 1975, a further 723 MW capacity, at the rate of 145 MW per annum, will have to be added. In physical size, this means the construction of a station of a size equivalent to that at Whakamaru (100 MW) every year for the first five-year period. A station larger than Ohakuri (112 MW) will have to be added every year for the following five years. Imagination rather boggles at the thought of what comes after that.

POSSIBLE SOURCES OF POWER

The four possible sources of power which might provide quantities big enough to meet the demands shown in the pre-

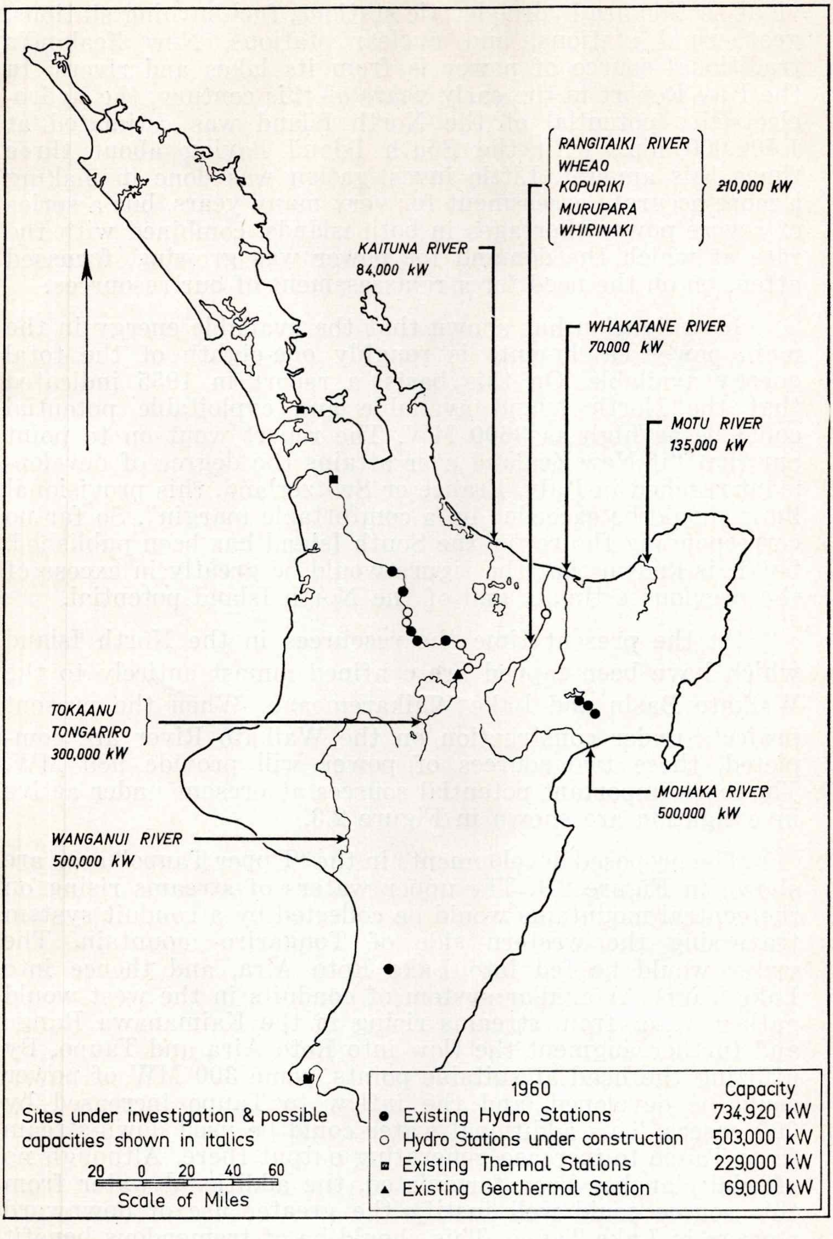


Fig. 2.3. Major power stations of the North Island together with those under construction (1960) and areas in which investigation of potential sites is being carried out. Estimates of possible potential are given for investigation areas.

vious section are hydro-electric stations, fuel-burning stations, geothermal stations, and nuclear stations. New Zealand's traditional source of power is from its lakes and rivers. In the Hay Report in the early years of this century, the hydro-electricity potential of the North Island was estimated at 1,500,000 h.p., with the South Island having about three times this amount. Little investigation was done in making a more accurate assessment for very many years, but a series of severe power shortages in both islands, combined with the rate at which the demand for power was growing, focussed attention on the need for a re-assessment of our resources.

Investigation has shown that the available energy in the main power catchments is roughly one-eighth of the total energy available. On this basis, a report in 1955 indicated that the North Island available and exploitable potential could be as high as 3600 MW. The report went on to point out that "if New Zealand ever attains the degree of development reached in Italy, France or Switzerland, this provisional limit should be exceeded by a comfortable margin". So far no corresponding figure for the South Island has been published, but it is known that the figure would be greatly in excess of the previous estimate and of the North Island potential.

At the present time the resources in the North Island which have been tapped are confined almost entirely to the Waikato Basin and Lake Waikaremoana. When the present projects under construction on the Waikato River are completed, these two sources of power will provide 989 MW. The more important potential sources at present under active investigation are shown in Figure 2.3.

The proposed developments in the "Upper Taupo" area are shown in Figure 2.4. The upper waters of streams rising on the central mountains would be collected by a conduit system traversing the western side of Tongariro mountain. The water would be fed into Lake Roto Aira, and thence into Lake Taupo. A similar system of conduits in the west would gather water from streams rising in the Kaimanawa Range and further augment the flow into Roto Aira and Taupo. By utilizing the head at suitable points, some 300 MW of power could be developed, and the inflow to Taupo increased by 600 cusecs. This additional water could be used down-stream from Taupo to increase generating output there. Although no official plan has been formulated, the additional water from this source could well justify the greater use of downward storage in Lake Taupo. This should be of tremendous benefit in dry years. The benefit arises from the fact that each foot of water in Lake Taupo represents a storage of 129,000,000 kWh.

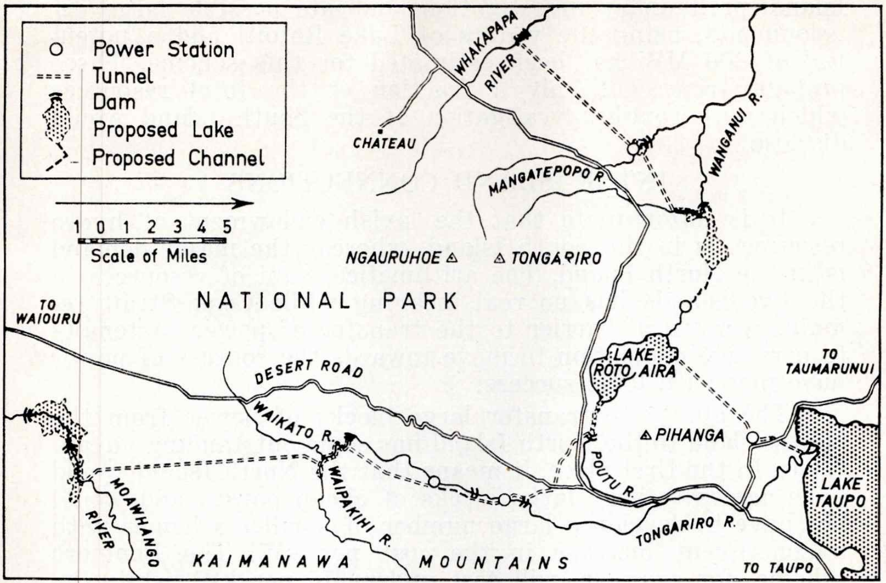


Fig. 2.4. Proposed development in the "Upper Taupo" area.

On the Rangitaiki River there are five sites for power stations with a total capacity of between 280 and 300 MW. One of these, at Matahina, has been authorised for construction , and will provide 70 MW. The power potential of the Kaituna River has been estimated at 58 MW, while other rivers of the Bay of Plenty may contribute a further 150 MW. This figure excludes the 135 MW which might be generated on the Motu River. The Mohaka and Wanganui rivers each have a potential of 500 MW.

Since the growth of the load in the South Island has been appreciably less than in the North Island, there has been less activity in investigation of resources. The Roxburgh Station on the Clutha River, with its full complement of machines, will be sufficient to meet South Island requirements until 1965. The giant Benmore Station on the Waitaki River, now planned to have a capacity of 540 MW, is due for operation in 1965. Other schemes have been investigated on the Waitaki River and, when fully developed, this river alone may provide about 1,500 MW of power.

The Manapouri scheme is capable of 1,000 MW development but under present government policy, is likely to be reserved for industry requiring large quantities of low-cost power. Investigations of North Canterbury rivers, such as the Hurunui, are not promising. The country is heavily faulted, and the lake storage inadequate. In the north of the South

Island, preliminary investigations indicate possible large developments, using the waters of Lake Rotoiti and a potential of 300 MW has been estimated for this scheme. These probably represent only a fraction of the total resources which a thorough investigation of the South Island would disclose.

INTER-ISLAND CONNECTIONS

It is unfortunate that the lavish endowment of hydro resources is in the South Island, whereas the major demand is in the North Island. The arithmetical sum of resources in the two islands has no real meaning while Cook Strait remains a physical barrier to the transfer of power. Attempts to persuade population to move towards the sources of power have met with little success.

The ability to transfer large blocks of power from the South Island to the North Island has some outstanding advantages. In the first place, it means that the North Island would have access to very large blocks of cheap power, and would not have to develop a large number of smaller schemes with a consequent increase in the cost per kW. The Benmore scheme, for example, will cost under £75 per kW, while the smaller Kaituna development could cost £150 per kW. Secondly, the water storage seasons in the two islands are complementary. A study of this factor by the Ministry of Works showed that, in the average hydraulic year, except during the months of April and May, surplus flows in the South Island power-producing rivers could be used to supply power that would otherwise have to come from North Island storage. Surplus flows in the North Island would meet the South Island demands in storage during July, August and September, so that there would be no draw on the South Island storage for North Island needs during these months.

It is interesting to note that, during the savage restrictions imposed on the North Island in 1958, enough water ran to waste over the South Island spillways to have provided for the unrestricted requirements of the North Island, had a cable link been available. Thus, it will be seen that a practical means of transferring power from the South Island to the North Island would enormously increase the overall resources of New Zealand, and would be of benefit to both islands.

This possibility, first envisaged by the Chief Electrical Engineer of the New Zealand Electricity Department in 1950, was carefully investigated by a firm of consulting engineers engaged by the government in 1957 and 1958. The conclusion given in their report to the government was that the transmission of large blocks of power was both practicable and economic. Numerous problems required detailed investigation

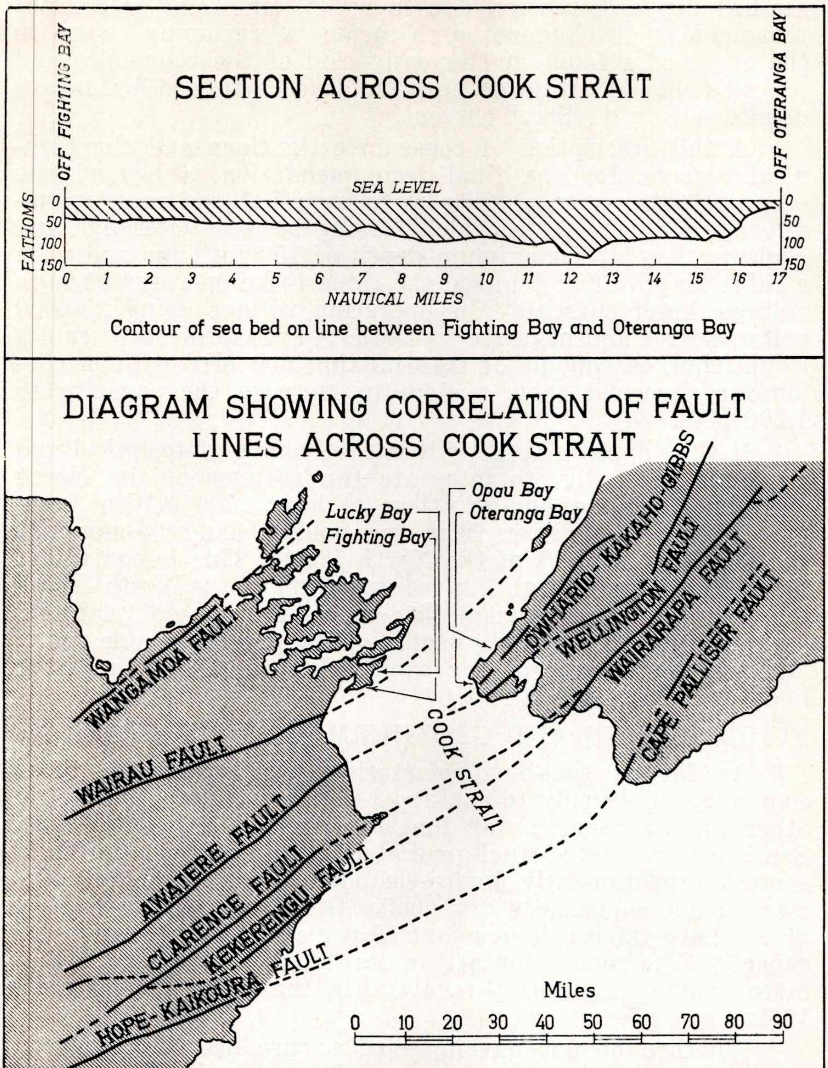


Fig. 2.5. Profile of Cook Strait cable route and relation of cable route to known fault lines.

before this conclusion was reached. These included investigation of the nature of the sea-bed from shore to shore to determine if a suitable route could be found; investigation of current strengths at sea-bed levels; consideration of the effect of fault lines adjacent to, or crossing, the cable route; design of a cable capable of withstanding the pressure at

sea-bed depths, abrasion due to rocks, and tidal or current movements; development of a means of repairing cables in the event of a fault, and investigation of the economics and practicability of transmitting the loads required by means of alternating or direct current.

A full description of these investigations and the technical reasons for the final recommendation is beyond the scope of this paper. Suffice it to say that the recommendations made were for a cable, crossing between Oteranga and Fighting Bay at a maximum depth of 150 fathoms and with a cable length of 25.5 miles, the cable to be operated at high voltage direct current - the operating voltage being 250,000 volts positive and negative to earth. A system of three cables would thus be capable of transmitting 600 MW with provision for a second cable system to increase the capacity to 1,200 MW.

It thus appears to be within the bounds of technical and economic possibility to integrate the systems of the North and South Islands, and to utilize at least 1200 MW of comparatively cheap power from the South Island to augment the smaller resources of the North Island. This is equivalent to the additional generating requirements of the North Island for 10 to 12 years beyond the end of the present planning period. Figure 2.5 shows a profile of the proposed cable route, and the relationship of the cable route to the known fault lines crossing Cook Strait.

FUEL-BURNING AND GEOTHERMAL STEAM STATIONS

As far as fuel-burning stations are concerned, these comments apply only to coal-fired stations, since we have no other known resources of fuel, such as oil or natural gas. Some percentage of fuel-generated power is essential in a system predominantly hydro-electric, to make up deficiencies during abnormally dry spells. Other countries similarly placed have fixed this at about 15 per cent of the total hydro capacity. The completion of the coal-burning station at Meremere will provide this percentage in the North Island until 1962.

Whether or not burning coal to produce electricity is putting it to its most economic use, I am not qualified to say, nor do I know the extent of our coal resources, which would be suitable for steam station use. Any station, to make an effective contribution to our power system, must be of large size consuming vast quantities of coal. Meremere, for example, is 180 MW and, on normal load factor, will use from 400,000 to 600,000 tons of coal each year. The requirements of such stations are a supply of coal suitable for opencast working and mechanical handling which is sufficiently large to provide the consumption during the economic life of the

station (say 40 years), and a substantial supply of cooling water. So far as is known, there are very few coalfields in New Zealand, which comply with these requirements but, even given these conditions, the cost of power is high.

Again, quoting the Meremere station, the capital cost is likely to exceed £100 per kW - rather more than that of a hydro station on a good site, and 50 per cent more than the cost of a similar station in Great Britain. The cost of electricity generated at the station busbars will be between 0.75d. and 0.8d. per kWh, or roughly three times the cost of hydro power. While, at our stage of development, such a station is an essential part of the national scheme it seems unlikely that we will be able to regard coal as one of the major resources for electricity production in the future.

GEOTHERMAL STEAM

It is more than 10 years since development work was started in the Wairakei thermal area on a project to harness geothermal steam, and although some £10,000,000 has been spent, the contribution made so far to our requirements of electricity is not spectacular. It is inevitable that a development of this nature should be clouded by a degree of uncertainty - uncertainty as to the quantity of power available, uncertainty as to the behaviour of plant, and uncertainty as to the duration of the steam flow. But, as geothermal steam is one of our natural resources, it is thoroughly justifiable that its possibilities should be investigated, and very true that a rich reward would result from successful harnessing of natural steam in vast quantities. Probably, the only difference of opinion that arises over this project is the extent to which we should, at this stage of our knowledge, place reliance on it.

It will be remembered that the early proposals for using geothermal steam were associated with the production of heavy water. The original lay-out of the scheme was to utilize high-pressure steam from the bores in the first section of the plant for electric power production, use the exhaust steam from this section in the production of heavy water, and, finally, use the remaining heat in the steam for power production in a third stage. The heavy water proposal was abandoned, and this section of the plant also became available for electric power production from steam at an intermediate pressure. The total output from this development was estimated at 69 MW and is now referred to as "Stage I Scheme".

One of the difficulties associated with power production form Wairakei is the fact that associated with the steam is a substantial quantity of hot water, which must be separated from the steam before it can be passed into the turbines. The hot water itself has a considerable energy content; it is,

in fact, about 65 per cent of the direct steam energy. Either this energy must be wasted, or means must be devised for extracting it and putting it to use. Either alternative presents difficulties. If 250 MW of power were developed from the steam alone, and the hot water discarded, it would mean the release of 3,500,000 pounds of steam per hour to the atmosphere and 75 cubic feet per second of boiling water would have to be disposed of in specially lined flumes conducting it from the wells to the river.

Since the hot water, as it comes from the wells, is under considerable pressure, it can be "flashed off" to provide low-pressure steam for operating low-pressure turbo-alternators. The principal difficulty is in preventing steam formation in the long pipe system carrying the hot water across the flat Waiora Valley to the power-house. The results of steam formations could lead to disastrous water-hammer phenomena.

Thus the two basic problems, the solution of which will determine the extent to which we can rely on geothermal resources, are the rate at which steam can be won and the successful utilization of the hot water associated with the steam. Until 1953, the drilling equipment available enabled only small bores to be drilled, with the production of moderate quantities of steam. Deep drilling plant was employed in 1954 and 1955, but, after successfully striking two deep bores, the results were disappointing. During 1956 the knowledge accumulated over several years was applied to the prediction of suitable sites, and deep bore steam was produced at a more consistent rate.

By early 1957, the total energy content - steam and hot water - which had been produced was equivalent to 160 MW, of which over 60 MW was represented by the hot water. At this stage, the Ministry of Works was confident that they could produce the equivalent of from 50 to 60 MW from combined steam and hot water per annum.

Towards the end of 1956, the consulting engineers employed by the government on this project made a comprehensive report dealing with the two problems mentioned above. They suggested "that it would be unwise to plan a station having a capacity of much above the figure of 250 MW until more positive evidence has been obtained that the necessary steam and hot water will, in fact, be forthcoming."

Dealing with the problem of the utilization of hot water, the report stated that "although we are confident that a hot water transmission system . . . could be made to work satisfactorily, it must be admitted that its precise behaviour cannot be accurately foreseen. Surging wells, sudden load changes and other transient influences may introduce problems of adjustment that cannot be tackled before they have been experienced. We, therefore, suggest that it would

be prudent to install a limited pilot scheme before embarking on the exploitation of hot water on a big scale."

The present position is that Stage I, with a gross capacity of 69 MW is nearing completion. Direct steam is used in this stage, and sufficient steam is available. Stage II will bring the capacity up to 151 MW and will use both direct steam and hot water, of which there is sufficient available for this stage. Stage III would complete the project to its full capacity of 250 MW and make use of direct steam and flashed steam but this development would require further supplies of both steam and hot water.

It will be seen, then, that the extent to which we can rely on resources of geothermal steam is still an unknown quantity. Various estimates have been made of the total potential available from Wairakei area. The department of Scientific and Industrial Research believe the field to be capable of producing 250 to 500 MW. Other estimates exceeding this figure have been given by various individuals, but these can be regarded only as assumptions unsupported by definite evidence. Until the difficulties of using both steam and hot water have been ironed out by experience and in a way which results in economic generation of electricity, this resource must be regarded as conjectural beyond the present planned development.

NUCLEAR POWER

In February, 1955, the British Government announced a 10-year programme of nuclear power development. By the end of this period, it was anticipated that nuclear power stations would be contributing from 1500 to 2000 MW of electricity to the national grid, replacing 5,000,000 to 6,000,000 tons of coal a year. By 1975 it was hoped that the generating capacity would be increased to 10,000 - 15,000 MW replacing 40 000,000 tons of coal a year; and that, by this time, the whole of Britain's new generating requirements (estimated at 3,000 MW a year), would be provided by nuclear power stations.

On 17 October, 1956, Her Majesty the Queen officially opened the Calder Hall Nuclear Power Station, the first of the 12 stations of the 10-year plan, and the first nuclear station of commercial size in the world. In view of these developments in Great Britain, it is pertinent to enquire if nuclear power is not the answer to New Zealand's power problem.

First we must look for the reasons for Great Britain's decision to replace its dependence on its traditional fuel - coal - with a dependence on nuclear energy. Great Britain stands alone in this. Neither U.S.A., the U.S.S.R, nor the great industrial nations of continental Europe have developed, or

even planned to develop, the peaceful uses of atomic energy as has Great Britain. The reason is not far to seek, and can best be expressed in the words of Sir Edwin Plowden, Chairman of the United Kingdom Atomic Authority:

> Industry depends on power. The revolutionary developments of the last 200 years have been based primarily on the exploitation of coal as a source of power. To coal has been added - within little more than living memory - oil. In some parts of the world, the force of flowing water has been used to generate electricity; but most of the world's power comes from fossil fuels - coal and oil.
>
> Now a new fuel and a new source of power is put to the service of mankind. The fuel is uranium, and the source of power is atomic energy. Scientists and engineers have found ways of adding to the world's store of wealth a new source of energy; a source with a potential large enough to allow the great industrial systems to continue hundreds - even thousands - of years beyond the time when the sources of power, on which we have hitherto principally relied, will have been exhausted. . . .
>
> This achievement has been of particular importance to the United Kingdom. . . . Coal was the foundation of our rise to industrial pre-eminence in the 19th century, but it is becoming increasingly hard to win in the ever greater quantities required by our continuing industrial development.
>
> Oil is being used more and more extensively but this country is poor in oil resources. The geography of this small densely populated island is such that water power does not, and cannot be expected to, meet more than a small fraction of our needs of power. Great Britain, therefore, stood more in need of some new source of power than countries which are larger or less densely populated, or which have vast resources of fossil fuel yet to exploit.

Great Britain's move towards a nuclear energy programme has been dictated by necessity - the necessity to find a substitute for her dwindling natural resources. Over the next 10 years, her power requirements will increase 40 per cent, while coal production is expected to increase only 11 per cent.

In the final analysis the source of power which is most suitable for electricity is a question of economics. The cost of producing electricity can be divided into two main components. The first is the annual fixed charges on the capital outlay. These include interest, sinking fund and depreciation charges. The second is the running charges, which include the cost of

fuel, operation and management, and maintenance costs. In the case of hydro-electric stations, the annual fixed charges, which must cover the cost of expensive headworks and foundations, are high, but the running charges are low. Coal or oil-fired steam stations are comparatively low in annual capital costs, but the running charges, involving the cost of fuel are high. Nuclear stations, at the present stage of development, have a high capital cost - hence high annual charges - and, since the cost of fuel is substantial, a fairly high running cost.

In recent years many prominent people, including university professors, have advocated the establishment of nuclear power stations in New Zealand as an alternative to further development of hydro power and inter-island connections. In view of these statements, it is as well to have a clear picture of the issues involved. In its report to the government in 1957, the Combined Committee on Electric Power Supply, discussing atomic power stations, stated that "at present, the best method of turning nuclear power into electric energy has not been determined". This statement was made with the full knowledge of the United Kingdom programme and is supported by the published statements of those responsible for committing the United Kingdom to its nuclear plans. Calder Hall, the first of Britain's nuclear stations to be commercialized, is a type known as a natural uranium, graphite moderated gas-cooled reactor, and is far from efficient. It has been compared with the "Model T" Ford car and the reciprocating steam engine. There are inherent limitations in this type of plant, which impose very definite restrictions on improvements in design to increase efficiency.

The cost of the Calder Hall station was about £300 per kW, as compared with £70 to £75 for a conventional steam station, although it is only fair to say that this plant was designed for the dual purpose of generating electricity and producing plutonium to be used in the enrichment of fuels for later nuclear stations. It is quite confidently expected that, with the improvements in design based on Calder Hall experience, capital costs of the new stations will be gradually reduced to below £150 per kW. Improvements in utilization of fuel can also be expected, which will still further reduce the cost per kWh sent out. But, with all the probable reductions in cost effective, the position, so far as New Zealand is concerned, is that atomic power cannot hope to compete with hydro power for very many years to come.

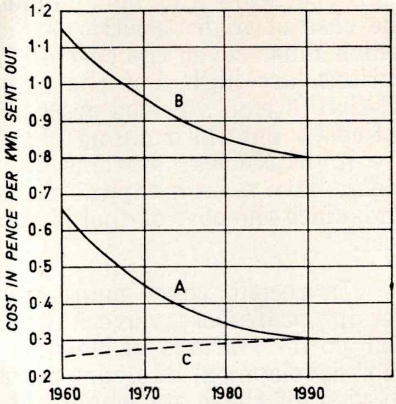
In New Zealand, we must expect the capital cost of nuclear stations to be very much greater than in the United Kingdom. Steam stations in New Zealand cost about 40 per cent

Fig. 2.6. Prospective nuclear power costs.

A: Great Britain.

B. New Zealand.

C. Hydro-power in New Zealand.



more than the equivalent stations in the United Kingdom and much the same ratio would hold for atomic stations. A 150 MW station in New Zealand with its initial fuel charge could be expected to cost about £30,000,000. Assuming a load factor of 90 per cent, the cost per kWh sent out from the station would be about 1.15d. This compares with 0.6d. per kWh for recent stations ordered by the United Kingdom Central Generating Board and 0.25d. per kWh for existing hydro stations in New Zealand. Sir Christopher Hinton has produced a graph showing his predictions of generating costs from nuclear stations of the Calder Hall type up till 1990 and this is shown as Curve A in Figure 2.6. Curve B is the probable cost of power from such stations in New Zealand, allowing for substantial increases in the cost per kW of installed plant.

It will be seen that, at the present stage of development, there is little justification for the establishment of nuclear plants in New Zealand, while we still have large resources of hydro power to develop. The government has prudently estabished an Atomic Energy Committee, whose duty it is to keep in touch with development in nuclear generation of power, so that, when the cost of generation falls to meet the rising costs of hydro power, this country will be ready to embark on an appropriate and economic programme of development.

Sir Edwin Plowden said not long ago that "nuclear technology offers such glamorous possibilities, that there is a serious danger of assuming that the potential improvements visualised for the future can be obtained now. The widespread use of nuclear power cannot help taking a considerable number of years."

CONCLUSION AND SUMMARY

I refrained in this survey from any mention of other somewhat unconventional sources of electric power, which from time to time are vigorously advocated by enthusiastic, through sometimes ill-informed, protagonists. These are, in the main, tidal power, wind power, and solar power. It is true that France has undertaken a gigantic development in tidal power that is quite unique. But the geographical and tidal conditions for such a scheme must also be unique for any economic and technical success. Any such scheme involves an immense amount of time and money for research and, at a stage of our development when we must build desperately with the known resources at hand, we have neither the time or the money. Wind and solar power also have their enthusiasts - and much experimental work on a small scale has been done with limited success. For the quantities of power we need year by year to satisfy the insatiable demand for electricity, none of these resources can help us.

And so, it comes down to the following facts. We have large resources of hydro power, which, if properly developed, could economically satisfy our needs for electric power for many years to come. By surmounting the natural obstacle of Cook Strait, as a barrier to transmission, we can greatly extend our dependence on hydro power. This can be amplified by the utilization of natural steam resources - though to what extent, we will not know for some years. But, by the time these natural resources are reaching their full economic development, we can turn, provided our present civilization remains intact, hopefully and confidently to the unlimited resources of nuclear energy.

THE PETROLEUM INDUSTRY OF NEW ZEALAND — PART I EXPLORATION AND PRODUCTION

J. S. Irving, Ph.D., M.A., B.Sc.*

This, the first of two papers on the petroleum industry in New Zealand, deals with the exploration and production phases, which are concerned with the provision of the basic raw material of the industry, crude petroleum. I use the word "petroleum" since "oil" conveys the picture of a liquid, whereas crude petroleum may be in the liquid, gaseous or solid state. This paper also deals briefly with the refining and manufacturing phase. The second paper will cover distribution and marketing phases.

First, as a background, let us look at the petroleum industry on a world-wide scale. The industry, although it celebrated its centenary in 1959, is still, from whatever viewpoint it is regarded, full of the vigour of youth. It is not yet the leading industry in the world, but is close to it. It is expanding at a rate which seems destined to give it a clear lead over other industries in a few years time. Even taking full consideration of the development of atomic energy, the world will remain critically dependent on abundant supplies of oil products if industrial expansion is to be maintained and the standards of living protected and improved. Very few countries can meet their oil requirements from internal sources of supply and even the United States of America is a net importer. The big reserves on which the world depends are largely in areas remote from centres of population and industrial development. It is these facts that have made oil by far the largest single item in international trade. Oil and oil products provide over 50 per cent of the total cargoes of ocean-going vessels.

The basic objective of the industry is to ensure that uninterrupted supplies of oil products are available in the right quantity and quality wherever in the world they are

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* Until his retirement in September 1960, Dr Irving was General Manager of Shell BP and Todd Oil Services Ltd. He has been closely connected with oil exploration in Taranaki. The author gratefully acknowledges the assistance of certain Shell Group publications in the preparation of this paper. Most of the figures are taken from J. W. Platt: "The Oil Industry, Its Place in the World and Its Future". Mr Platt is a Managing Director of the Shell Petroleum Company Limited.

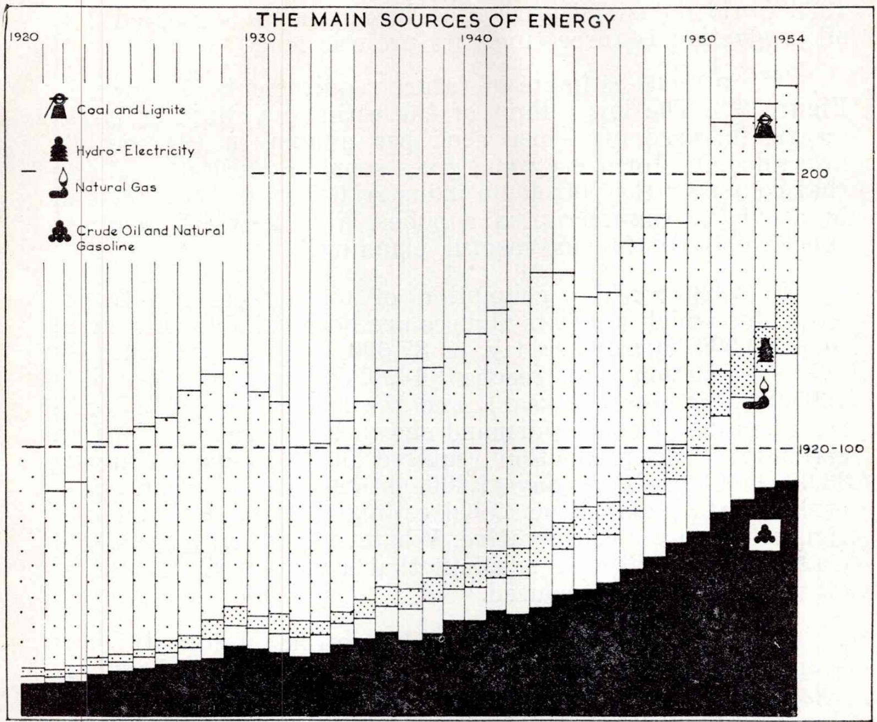


Fig. 3.1. The main sources of world energy, 1920 to 1954.

required. It is obvious that the large integrated international company is in the best position to achieve economically such an objective, which demands the closest co-ordination of all the various phases from exploration to finished products. At this stage, I should like to draw your attention to two particular aspects of this task confronting the petroleum companies, two factors to which I shall again refer when I come to deal with the separate phases of this industry. First is the requirement of "uninterrupted supplies" and secondly, the "pattern of demand".

In connection with this question of "uninterrupted supplies", let us look at the universal growth of the demand for petroleum products. Figure 3.1 shows how world energy requirements have expanded since 1920 and how petroleum's contribution has gathered momentum. Figure 3.2 illustrates the same growth in another way. In 1955 world energy consumption was two and one-third times that of 1920. In the same period the consumption of petroleum fuels increased almost sevenfold, their contribution going up from one-seventh to over one-half of the effective requirements. Since

1938 world industrial production has more than doubled, but oil production is three times its pre-war level.

The present estimate of future requirements is shown in Figure 3.3. The lower limit of the estimated range is based on an increase of 3 per cent per annum in the world's gross demand for energy and gives some measure of the task that confronts the petroleum industry if it is to be successful in providing uninterrupted supplies, a task which requires timely and continuous careful planning.

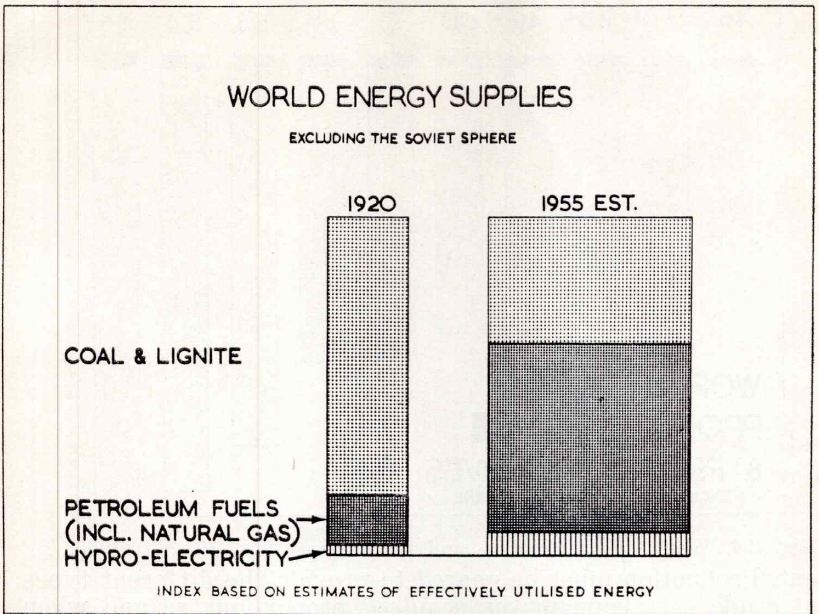
In 1920 world consumption of oil outside the Soviet block, for which accurate figures are not available, amounted to 1,800,000 barrels per day, or 87,000,000 tons per year. By 1955 production had reached 14,325,000 barrels per day (695,000.000 tons per year), and the lower limit of the estmated range of energy demand shown in Figure 3.3 gives an estimate of oil production required in 1975, amounting to 33,000,000 barrels per day (1,600,000,000 tons per year). Several experts making their own estimates have declared this figure to be over conservative. Whatever your own preferred estimate, you will have to admit that a very large amount of oil will have to be produced.

Figure 3.4 illustrates how the petroleum industry has been able to meet the growth of demand to date and how it is providing for further expansion through intensive exploration resulting in the expansion of proven reserves. The average increases in proven reserves have exceeded the average annual production. This cannot go on for ever, but does establish that we can safely expect the ultimate recoverable quantities of oil in the ground to prove high enough to meet the increasing needs of the world economy as it moves into the age of atomic power.

The growth in number and complexity of the products derived from crude petroleum has contributed to the growing importance of the industry. Crude oil was first used medicinally, then produced mainly to provide kerosene for lighting. Today over 2,000 products are made from crude petroleum, ranging from heavy black furnace oils and bitumen to the meticulously prepared chemical raw material for a pair of nylons.

THE NEW ZEALAND SCENE

The main phases into which the industry's activities naturally fall are exploration, production, refining and manufacture, and distribution and marketing. The necessity for continued exploration in order to ensure long-term supplies of raw material for the industry - crude petroleum - is appar-



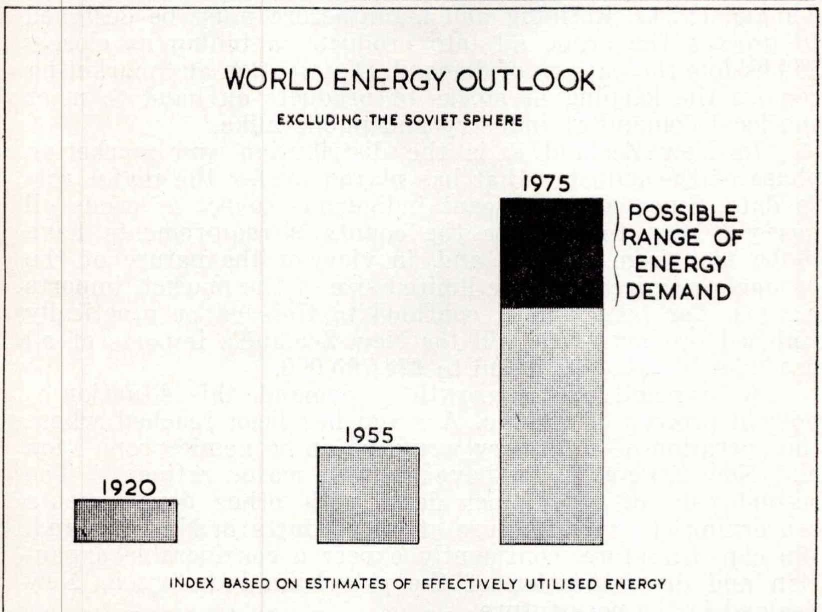


Fig. 3.2 and 3.3. Growth of world energy supplies by source, 1920-55, and possible demand in 1975.

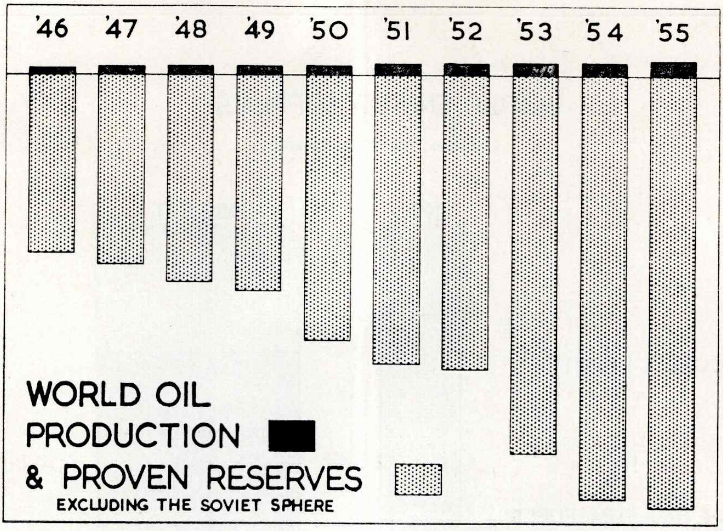


Fig. 3.4. World oil production and proven reserves, 1946 to 1955.

ent. Production must be geared to provide the different types of crude petroleum in the required proportions as and when demand exists. Refining and manufacture must be designed to process the crude oil into products matching as closely as possible the pattern of demand. Distribution and marketing require the keeping of stocks of products on hand to meet the local demand of industry and public alike.

In New Zealand it is the distribution and marketing phase of the industry that has played by far the major role to date. Since no significant indigenous source of crude oil has yet been found here the country's requirements have to be met from imports and, in view of the nature of the products required and the limited size of the market, imports have so far been almost confined to finished or practically finished products. The bill for New Zealand's imports of oil products in 1959 amounted to £23,700,000.

As a result of the growth of demand, this situation is now in process of change. A stage has been reached where the operation of a refinery would be an economic proposition and New Zealand is to have its own major refinery.† The second part of this paper deals with other developments concerning the manufacture of oil products in New Zealand. We can, therefore, confidently expect a considerable expansion and diversification of the petroleum industry in New Zealand in the near future.

† It was announced in November 1960 that the refinery will be located at Whangarei. The capital cost of the refinery is likely to be about £20,000,000. (Editorial Note.)

Another very definite sign that the industry is actively investigating all New Zealand's possibilities is the present intensive exploration effort. It is not always realized that the search for oil in New Zealand has been going on intermittently for almost 100 years. It was in 1865, only six years after Colonel Edwin Drake sank, in Pennsylvania, the world's first well drilled for oil, that attracted by seepages on the beach and offshore at New Plymouth, New Zealand's first exploratory oil well was started. Since that time over 90 wells have been drilled in many parts of the country, but little more than signs of oil have ever been found. Only at New Plymouth has a very small but sustained production been obtained.

The main periods of oil exploration activity in New Zealand were 1910-20 and 1938-42. Most of the campaigns, particularly those undertaken by large international companies, were serious well-planned efforts to find oil. They were unsuccessful but they did eliminate certain possibilities, contributed a considerable amount of data on the geological conditions and provided pointers which were of help to those who took up the search later. Today, exploration activity is probably at as high a level as ever previously reached. Figure 3.5 shows the areas over which petroleum prospecting licences have been issued by the Department of Mines. Over 23,000 square miles are covered by these licences.*

Shell BP and Todd Oil Services Ltd. began a survey of its concessions in Taranaki at the end of 1955 with technical staff from the Shell Group, who act as advisers and provide the benefit of their world-wide experience. After a photogeological survey of the area, surface geological surveys, a gravity survey, magnetometer survey and extensive siesmic surveys, a location for an exploration well was selected on what was considered to be the most promising structure. The well, known as Kapuni No. 1 was drilled last year to a total depth of 13,040 feet and discovered an accumulation or reservoir of petroleum. This petroleum, however, was in the gaseous state and when the well was tested, a flow of gas was obtained from which a quantity of liquid hydrocarbons condensed and could be collected. From data collected during the tests it could be concluded that under reservoir conditions the petroleum was a gas. This result was considered sufficiently promising to warrant an intensified search and preparations are in hand for the drilling of a second and probably deeper well in Taranaki.

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* Since this paper was written and Figure 3.5 drawn an American company has been granted a concession over some 1800 square miles extending between Shannon and Waiouru. (Editorial Note.)

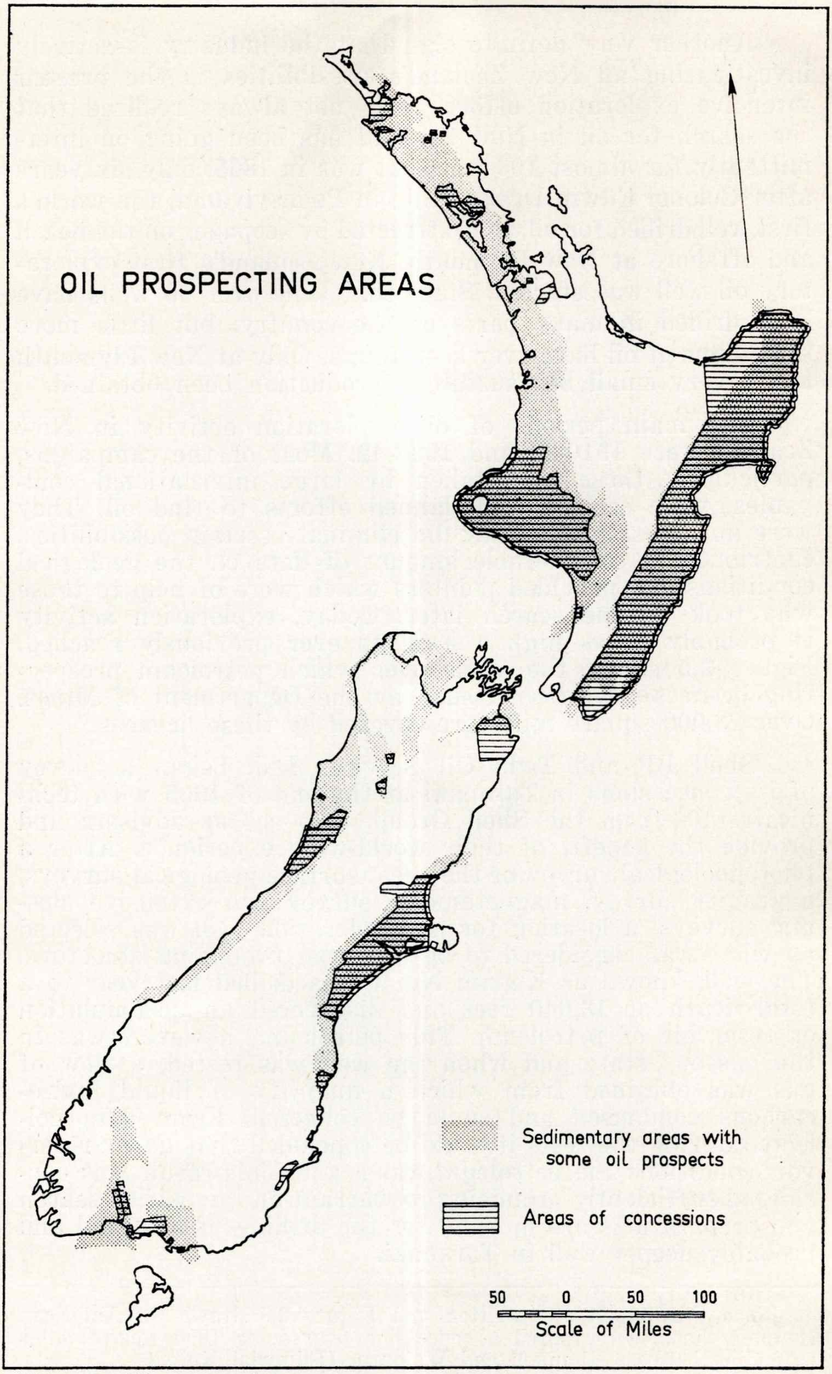

Fig. 3.5. Oil prospecting areas.

BP Shell and Todd Petroleum Development Ltd. hold a block of licences on the East Coast. After three years of surface geological and seismic surveys, they selected an exploration well location in the Mangaone Valley near Wairoa. After a postponement due to difficulties with the access road in abnormally wet weather, drilling of this location, Mangaone No. 1, started at the end of June 1960. Todd Brothers have also carried out geological and gravity surveys on concessions held by them near Ruatoria and in the South Island.

When one compares the size of the areas in New Zealand which have any possibilities of having commercial-sized accumulations of oil with the large sedimentary basins of other countries one cannot but conclude that the search efforts now under way are a very thorough investigation of the prospects. To date over £6,000,000 has been spent on the search for oil in New Zealand, £2,000,000 of which represents the cost of current efforts in Taranaki and the East Coast of the North Island by the Shell BP and Todd Group.

The question is sometimes asked: what is the reason behind the increase in activity in recent years? It is simply that the earlier efforts, while unsuccessful, did not conclusively condemn the prospects. There is a world-wide increase in the effort to find more oil to meet the world's increasing demand. As was shown above, in their own long-term interest the oil companies must continue to plough back into exploration a large percentage of their income, and New Zealand still offered some chance of finding crude oil supplies close to an established market. In the competition with other countries to attract exploration capital, New Zealand also gained by having a stable political situation and a reasonable Petroleum Law, under which the operating companies could have some confidence that if they invested the large amount necessary for thorough exploration and were successful, they would be allowed to develop and eventually recover their risk capital. That, then, is why New Zealand now has a full-scale exploration in progress.

Skill, money, an adequate prospective area and a willingness to gamble are prerequisites to success in oil exploration - let us hope that some of the present efforts will have the desired result of providing at least a good proportion of the raw materials required to meet this country's needs for petroleum products.

The second phase of the petroleum industry is production. So far there has been no chance to develop this phase in New Zealand. Approximately 28,000 tons of crude oil have been produced from wells in New Plymouth over the

years and Egmont Oil Wells Ltd. continue to produce some two and one-half tons per day. Such a small output can scarcely be called commercial production, even although the oil is obtained from the shallow depth of 2,200 feet. A high proportion of water and some gas is produced along with the oil. The gas is sold to the New Plymouth gas works for mixing with coal gas. It appears that the size of the reservoir from which the oil is coming is small and that there is little chance of being able to increase the production significantly by development work. If attempts were made to increase offtake, it is probable that the result would be simply an increase in the proportion of water.

In consideration of possible future developments of this phase, which at the present time is little more than crystal-gazing, several points must be borne in mind, particularly the question of the time that must pass before an exploration discovery can be brought to the producing stage. An initial discovery is not always a guarantee of a successful venture. Often several wells must be drilled and a considerable amount of oil has to be produced before the ultimate recovery from the field can be reasonably estimated. It will be readily understood that such an estimate is required at the earliest possible stage so that it can be judged whether there will be at least a reasonable chance of recovering the costs of exploration and development drilling, production, tankage and transport, let alone some private profit. Wells to a depth of 13,000 feet may cost £200,000 - £300,000 each. This cost can be fairly accurately estimated, but other factors such as the percentages of the actual oil in place that can be recovered are much more difficult to foretell. In some fields only 25 per cent of the oil in place is recoverable. This figure can sometimes be increased to 50 per cent or over by what are called "secondary recovery" methods, such as water-flooding or gas injection. Either process involves a considerable extra investment.

If a high proportion of gas has to be produced with the oil, the economics become still more complicated. Spare gas was once flared at the well-head. This is a wasteful operation, but it takes a considerable time to plan and still more capital investment to process gas to a saleable product and to develop a market. Estimates of the quantity of gas in a reservoir, too, are much less certain than estimates of oil. The gas found at Kapuni, for instance, has a high proportion of carbon dioxide which would probably require to be removed before it was usable. A great many very uncertain factors have to be fully ascertained before any sound assessment can be made as to whether or not a discovery is commercial. That

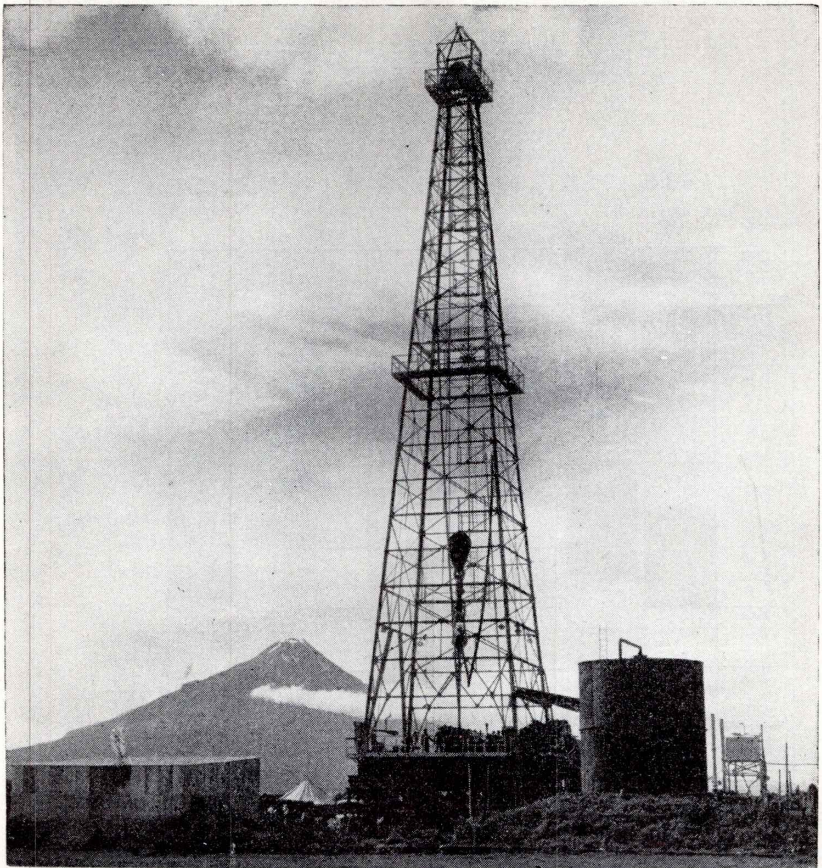

Plate III. Spudding in of Kapuni No. 1 well, 1959.

however, is just one of the features of this production phase, a feature well known to experienced industry operators.

The refining and manufacturing phase I will treat in a very cursory manner. It is almost an industry in its own right and will be developed in New Zealand in the near future. The advantages of having a local refinery have been set out elsewhere by Dr Sutch, Secretary, Department of Industries and Commerce[1]. I should, however like to emphasize the necessity for tailoring a refinery to meet the "pattern of demand". Figure 3.6 illustrates varying "patterns of demand" in different parts of the world.

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1. W. B. Sutch, "The Oil Industry in New Zealand". Paper read to Wellington Manufacturers' Association (Manawatu Branch), 6/6/59.

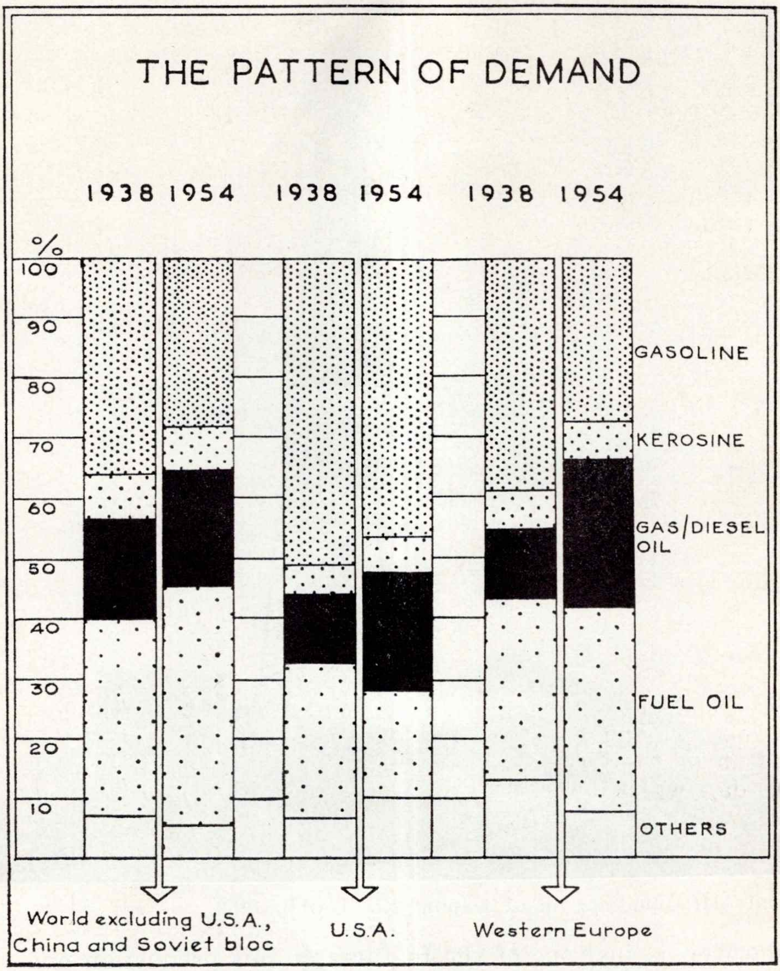

Fig. 3.6. World Patterns of Demand.

The New Zealand pattern, with its large proportion of motor spirit, is rather similar to that of the United States and no normal crude will yield products in the required proportions. It would be better to import an enriched crude, but at the same time the design of the refinery must be sufficiently elastic to enable it to process economically any indigenous crude which may eventually be found. The planning and erection of a refinery is a huge project which cannot be undertaken lightly.

The manufacture of chemicals from petroleum is a relatively new but rapidly expanding side of the established

oil and chemical industries. During the last 15 years world production of petroleum chemicals has grown from about 1,000,000 to over 13,000,000 tons per annum, and the scope for future development remains enormous. The principal raw materials are refinery by-products - mainly refinery gases - and natural gas, which are otherwise used as fuel. The main fields of petroleum chemicals are chemical solvents; synthetic detergents; plastics and resins; synthetic rubber; synthetic fibres from petroleum chemicals; and agricultural chemicals such as fertilizers, insecticides and weed-killers. The manufacture of such products is another phase of the industry which may develop in New Zealand in the future.

PART II

DISTRIBUTION AND MARKETING

A. M. Harvie, M.A.*

Oil is playing an increasingly important role in the national economy of New Zealand. It accounts for some 8 per cent of the country's import bill and its use is expanding daily. The growth of demand in New Zealand for petroleum products during this century has been phenomenal. A comparison of the first available figures with those of the present-day will show just how great it has been. In 1896 the consumption was 6,000 tons, mainly of kerosene; by 1950 the figure of 1,000,000 tons had been reached, which included bunkers to ships arriving at New Zealand ports; and it had grown to 1,650,000 tons by 1959. At this rate of expansion it is well within the bounds of possibility that the 2,000,000 mark will be reached by 1964.

If we reduce the figure for 1959 to a per capita basis, the consumption of petroleum products is 180 gallons, an increase of 43 per cent since 1950. This is one of the highest rates in the world and compares with 115 in the United Kingdom, slightly over 200 in Australia, 214 in Scandinavia and 600 in North America. In proportion to our population the number of motor vehicles in this country is very high; in fact it is the highest in the world outside North America. At the end of 1959 there were 822,000 registered vehicles and just over 500,000 of these were private cars. This figure means one car for every 4.7 persons and there is still a large unsatisfied demand.

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A feature of the New Zealand consumption pattern is the very heavy demand for motor spirit, which accounted for approximately 57 per cent of the total consumption in 1959. Expressed in gallons this is 255,000,000, a big increase over the figure of 144,000,000 recorded for 1950. In the immediate post-war years there was a regular 10 per cent annual increase which steadied somewhat later and received a temporary severe check after the 1958 budget. The trend this year is again strongly upward and already shows an 8 per cent increase over the same period last year.

Of paramount interest to consumers is the question of motor spirit quality. Immediately before the war we had a two-grade market based on a standard grade, with an octane rating of about 70 (M) and a premium grade with an octane rating of about (78 (M). The outbreak of war disrupted normal marketing arrangements and with supplies coming from many different sources the quality fluctuated during this period. On the cessation of hostilities a one-grade market emerged and that grade had an octane rating of 72 (M). In 1954 this was upgraded to 79 (R) and there it has remained. After considerable negotiation with numerous interests, the government agreed to an octane rating of 83 (R) in October 1960 and the introduction of a premium grade of 93 (R) about March 1961. The next move depends on the engine manufacturers, but these two grades should fill the bill for some time.

The introduction of a new grade to the market is not an easy task and calls for heavy capital expenditure to provide storage and handling facilities at our own depots as well as at service stations. In this connection the saving in cost by one-brand marketing is considerable and serves to emphasize the advantages of this method of distribution.

The price of motor spirit has not fluctuated to any extent over the last 10 years. If tax is disregarded, motor spirit costs 1.05d. per gallon less today than it did at the end of 1950 and the tax-free price has been constant since October 1957.

The distribution of motor spirit is a very important part of our business and a highly organized part. Originally motor spirit was shipped to this country in tins and cases, but since the Shell tanker "Murex" discharged the first bulk cargo of 8,000 tons at Miramar on 20 January, 1926 all supplies have come to us in bulk tankers.

Bulk supplies have traditionally been arranged through the four main ports, where overseas tankers regularly discharge. From there our coastal tanker has distributed the cargo to a growing number of secondary ports where a price

differential of 1d. per gallon has been charged. As the market has developed, oil company and harbour facilities have improved to the extent that more motor spirit is now being delivered direct to the secondary ports by overseas tankers and some of the previous justification for the 1d. differential has disappeared. This is one of the reasons for the recent decision to eliminate these differentials entirely.

Deliveries from the coast to up-country areas are made either by rail to oil company depots or by road, and price differentials (though full of anomalies) are based largely on the cost of transportation. The elimination of the port differential has now provided a broader base for up-country differentials, and the oil companies and the government are now engaged on a review of the existing structure with a view to its further simplification.

From up-country depots deliveries are made by road tanker to customers' tanks. Supply in drums is falling off rapidly as more and more farmers install underground tanks on their properties. This is a particular feature of trading in the South Island. It is difficult to ascertain the exact number of farmers who now have their own storage tanks, but it must be close to 15,000 of whom nearly 12,000 are in the South Island. At service stations, where the greater part of our business is done, the trend is strongly towards the installation of larger tanks. This trend is, of course, particularly in evidence at one-brand stations, which are a potent factor in keeping distribution costs down.

The development of airlines and aerial top-dressing has led to a very large increase in consumption of aviation fuels. While the piston engine predominated, the demand for aviation gasoline in its many grades was continually increasing. In 1939 the whole New Zealand offtake was less than 1,000,000 gallons. By 1956 this figure had risen to nearly 10,000,000 gallons. Progress since then has been largely in the turbine field and aviation gasoline demand has remained fairly stable at between 10,000,000 and 11,000,000 gallons. The few turbine-powered aircraft such as Vampires, Viscounts, and Electras, which burn aviation-quality kerosene, are now devouring this product at a rate of 7,500,000 gallons per annum, making the total aviation fuel market about 18,500,000 gallons. When the N.A.C. Dakotas are replaced with Fokker Friendships and the fourth Viscount is in service, there is no doubt that the demand for the kerosene-type fuel will entirely outstrip the demand for aviation gasoline. This is going on all over the world and is a good example of a change in the pattern of products that refineries have to extract from the crude.

Today, aircraft use enormous quantities of fuel and the demand is now for quicker and quicker turnrounds. An aircraft like the Electra, for example, will burn up 2,000 gallons on an average Tasman crossing and the time available for refueling is seldom more than 30 minutes. This rate of fueling is something which cannot satisfactorily be handled by mobile refuellers and a more efficient and considerably cheaper method is the use of a hydrant system. In this refuelling system the fuel is forced at pressure from bulk tankage at an adjacent depot, through underground pipelines to the hydrant pits. From these pits, which are set in the ground on the tarmac, the fuel is pumped into the aircraft through a dispenser fitted with a microfilter and pressure-control valve, and the fuelling of the aircraft is similar in principal to the refuelling of a motor car from a dispenser pump at a service station. Hydrant fuelling means that the amount of equipment on the tarmac around an aircraft is cut to a minimum. The system at Harewood is designed to supply fuel to an aircraft at 600 gallons per minute, and an aircraft like a Boeing 707 is designed to receive fuel at this rate. Big changes have taken place in the use of kerosene over the last couple of decades. Earlier, power kerosene was very widely used for agricultural tractors. Today, however, most tractors are using motor spirit or gas oil and the demand for power kerosene has fallen right away. On the other hand, demand for lighting kerosene has increased enormously because of the widespread use of kerosene heaters. In the winter months last year the monthly demand was well over 1,500,000 gallons and this year (1960) it seemed to be even greater.

The bitumen market continues to grow and last year some 53,000 tons were imported, mainly for roading purposes. There are three bulk bitumen installations now operating at Auckland, Wellington and Lyttelton, and a fourth is being erected at Bluff by another company. Instead of arriving in drums - which for 53,000 tons would cost £400,000 in overseas exchange - bitumen now arrives in specially heated bulk tankers. It is pumped ashore to our storage tanks at a temperature of 260°F. and is heated to 285°F. before being distributed by rail tank car or road wagon. We import two grades in bulk and blend them in various proportions for different purposes. Bulk importation has caused a very substantial drop in the local selling price.

Space allows only a brief mention of other developments such as the very large market that is developing for gas oil, largely as the result of the growing dieselization of the railways and the swing towards gas oil for agricultural tractors. There is also a growing importance of petroleum-based chemicals which are opening up very wide fields, particularly

for agricultural purposes. The major oil companies are now supplying literally hundreds of products of the most diverse nature. Consider these: fuels (gasoline, kerosene, aviation gasoline, aviation turbine fuel, gas oil, fuel oil, furnace oil, liquid petroleum gas); hundreds of lubricants; wax and candles; bitumen in a variety of grades; white spirit; turpentine; plastics; synthetic rubber; synthetic detergents; synthetic textile fibres; chemical solvents; glycerine; fertilizers; pesticides; weedkillers; and that is to mention just a few of the many varied products developed by various processes from crude petroleum.

FORESTRY AND FOREST INDUSTRIES

Murray Chapman, B.A. and R. Gerard Ward, M.A.*

To Europeans visiting New Zealand in the last two decades of the eighteenth century, the forests were the country's most obvious resource. It is probable that at that time approximately two-thirds of the country's total area was forested. The kauri forests of the north and the kahikatea stands of the lowlands attracted the most interest. In 1794 a shipment of spars for the Admiralty may have marked the start of New Zealand's timber[1] export, but it was not for another 20 years that anything approaching a regular trade was established. By the mid-1820s timber was being sawn at Kororareka (Bay of Islands) and before 1840 the trade had increased to the extent that there were signs of a glut of kahikatea on the Sydney market.

Kauri formed the basis of New Zealand's timber industry until at least the 1880s. By this time steam-powered mills had made possible a great increase in output and in 1871 at least 3,000,000 superficial feet of timber was exported. By 1880 exports had risen to over 13,000,000 superficial feet, the greater part of which was kauri. The major internal demand was also for kauri and other species such as rimu, matai, miro and beech, which today are the major suppliers of indigenous timber, were generally ignored. As a result of this, together with indiscriminate burning and wasteful milling techniques, a great part of the forest resource was lost. By 1873 the 4,000,000 acres of kauri forest in North Auckland had been reduced to 1,200,000 acres[2]. In 1886 Kirk predicted that if the consumption of kauri continued to increase

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1. In this paper 'wood' and 'lumber' are used synonymously to refer to the fibrous raw material contained in a stand which has not been clear felled. 'Timber,' on the other hand, is used only where logs have been extracted and some form of conversion, for example, sawing, has taken place.
2. S. E. Masters et. al.: "The National Forest Survey of New Zealand, 1955," Vol. I, Wellington, 1957, p. 3.

at the existing rate, the supply would be exhausted within 15 years[3].

Long before this there had been some recognition of the need for ensuring adequate forest resources for the future. The planting of exotic species by private individuals, particularly in Canterbury and Otago, began shortly after European settlement, and in 1871 the Forest-Tree-Planting Encouragement Act gave support to this trend by granting land equivalent to the value of £4 for every acre planted. The Act was extended in 1879 to cover public bodies but it was repealed in 1885. It was a strange feature of the resource appraisal of the period that in one area the most valuable indigenous timber should be so wastefully used whilst elsewhere the need to extend the forest resource was recognised. By the mid-1880s, concern for the future of the timber industry was growing. Kirk's report was symptomatic of this concern and clearly illustrates many aspects of the industry of the period. In Westland, the industry was in decline "the coastal trade having completely passed away" as the accessible and easily milled forests of Southland were exploited. Westland could not compete, for rail transport gave the Southland miller considerable advantages. Elsewhere the industry showed the migratory nature which was to be characteristic for the following 60 years. In Marlborough "most of the forest near the sea [had] been practically worked out" and Kirk recorded that he was "fully convinced that the present supply [in Hawkes Bay] will be exhausted within the next ten years". In the Wairarapa totara groves were "becoming very rare". As the forest edge was pushed back so the mills followed.

For 20 years after Kirk reported to the government, the process of forest removal continued, to reach a maximum acreage between 1890 and 1895. The forests of the Wairarapa and Hawkes Bay disappeared, those of Northland were further diminished and from the Manawatu plain the millers pushed north into the hill country along the route of the main trunk railway. The production of timber continued to climb steadily until it reached its peak in 1907. Exports reached the high point of 84,554,000 superficial feet in the following year. By this time the kauri had lost its place to rimu as the major timber supplier within the country and kahikatea was the main export timber. After 1907, production fell until after World War I. Simultaneously, the indiscriminate cutting of the indigenous cover slowed, but already the forest area had been reduced by nearly two-thirds in 60 years.

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3. T. Kirk: Native Forests and the State of Timber Trade, "Appendices to the Journals of the House of Representatives" (A.J.H.R.), C-3, 1886, p. 25.

The main cause of forest removal, however, was the demand for land for farm settlement and not the requirements of the timber industry. With wasteful milling techniques and indiscriminate burning, more timber was probably lost than was ever milled. As G. S. Perrin pointed out when the destruction was at its height, "the theory that 'a man who makes two blades of grass grow where one grew before', no matter what he destroys to accomplish this, is a benefactor, was universally accepted."[4]

AFFORESTATION

In addition to warning that "nothing short of drastic legislation . . . can save the timber reserves from practical extinction within the next thirty or forty years", Perrin stressed the need for establishing exotic plantations. He predicted that "the pumice plains will one day be covered with fine forests, and . . . that these tracts of country will become a valuable asset", In 1896, as a result of a timber conference called by the government, a forest policy was laid down based on the establishment of introduced species. Experimental plantings were made on the Volcanic Plateau and these were followed by more extensive afforestation in both islands so that by 1908 some 9,500 acres were in 10 state-owned plantations.

As the indigenous forest area continued to decrease concern for future timber supplies increased and in 1913 a Royal Commission recommended an increase of two and one-half times in the acreage of exotic trees planted annually[5]. World War I prevented execution of this recommendation, but shortly after the war, as the demand for timber boomed with a new wave of housing construction, the problem again came into prominence.

Between 1920 and 1923 a national forest inventory revealed that the forest area totalled only 12,600,000 acres and less than half of this was merchantable. Under the guidance of McIntosh Ellis, first Director of Forestry, a programme was begun through which the state was to plant 300,000 acres of exotic trees within 10 years. It was expected that a further 100,000 acres would be established by private enterprise. The years 1926-34 saw a tremendous surge in afforestation. As the effects of the depression were felt forest planting provided relief work for many hundreds of unemployed men. By 1934, 376,000 acres had been established by the state while

4. G. S. Perrin: Conservation of New Zealand Forests, "A.J.H.R.", C-8, 1897, p. 6.

5. Report of the Royal Commission, "A.J.H.R.", C-12, 1913.

plantings by private interests amounted to a further 300,000 acres or three times the original estimate[6].

By 1936 New Zealand possessed over 750,000 acres of exotic forests, almost 70 per cent of which were concentrated in the central North Island. Eighty per cent of these plantations were under 10 years of age and the bulk of them were radiata pine. It soon became clear that such a large area of forest, virtually all of the same age and species, created many problems. As the country recovered from the depression, low-cost labour was no longer available and large-scale planting ceased. Since that date emphasis has been placed on the establishment of small forests near market areas and in timber deficient districts; on widening the range of species and matching species to sites; on improving the quality of nursery stock, and on the silviculture of existing forests. It has now become clear once more that if New Zealand's forest industries are to continue to expand the acreage under exotic forest will have to be increased still further. The present surplus of timber could disappear by 1985 if population and per capita consumption continue to increase at present rates. Plans have recently been formulated to provide a further 2,000,000 acres of exotic forest by the year 2025, while in the meantime the benefits of the planting boom of the 1920s and 1930s are being gathered. Exotic forests now produce 51.2 per cent of the timber output (1959-60) as well as providing the raw material for the new pulp and paper industries.

CONTEMPORARY FOREST UTILIZATION

Each year wood-using industries in New Zealand consume 150,000,000 cubic feet, employ a workforce of almost 30,000, and contribute at least £45,000,000 to the national economy. Although indigenous species cover one fifth of the total land area, exploitation is confined to those few areas of virgin forest which are merchantable[7]. Several problems, and in particular the combination of a slow rate of growth and difficulties in successful regeneration, must be solved

6. A. R. Entrican: Development of the Exotic Forest Resource as a Major Land Use, "Proceedings Industrial Development Conference," June, 1960; P. G. Thyne, "A Geographical Study of New Zealand Exotic Forestry Resources and Industries," Unpublished M. A. Thesis, University of New Zealand, 1954.

7. The National Forest Survey of New Zealand defines merchantable stands as "those which are of sufficient extent, of sufficiently high quality, and of sufficiently high volume per acre, having regard to topography, to permit economic exploitation either immediately or within the next several decades. The sole criterion is whether or not the stands could be logged economically with employment of the best of known logging techniques." (Masters: op. cit., p. 5.).

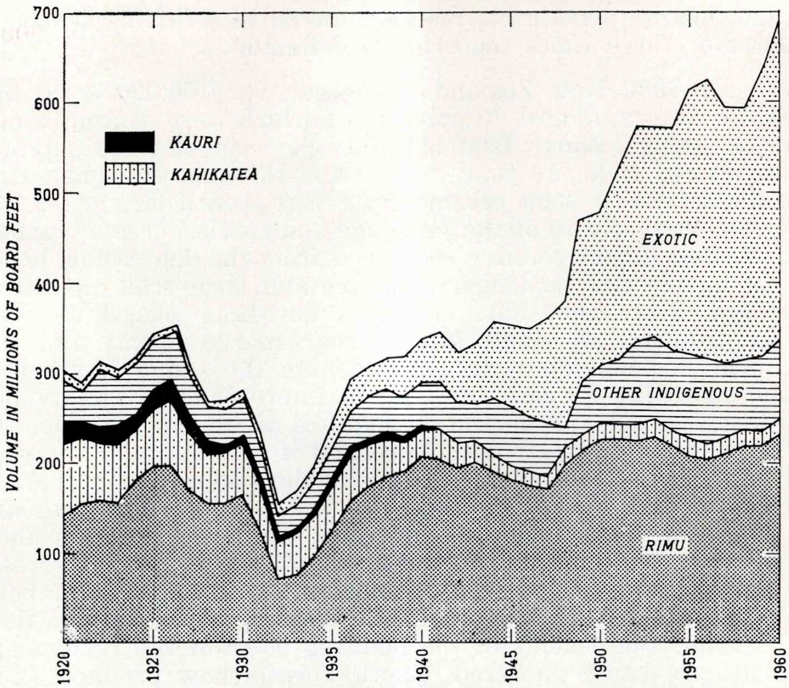

Fig. 4.1. Timber production by species 1920-60. (Source:- N.Z. Forest Service: "Statistics the Forests and Forest Industries of New Zealand", Wellington, 1957, and "A.J.H.R.", C-3, 1958-60.

before sustained yield[8] is assured. Man-made forests of coniferous species, on the other hand, cover only 1.4 per cent of the total land area, but are notable for their short rotation and rapid rate of growth. It is to the exotic pine that forestry and forest industries will look in the future, for much of the indigenous forest cover must be preserved to regulate run-off and prevent soil erosion.

Sawmilling is a mixture of the old and the new. The larger units, which produce more than 10,000,000 board feet of timber a year, are concentrated in the central North Island and cut only exotic species. Such sawmills are integrated with other forms of wood conversion such as box-making as at Waipa, or the processing of sulphate pulp and newsprint, as at Kawerau. (See Appendix 4.1.) Electrically operated and employing the latest Scandinavian techniques, these mills are highly mechanized, engage only a small proportion of the total workforce in the actual sawing, and account for 21.8 per cent of the timber produced in New Zealand.

8. Sustained yield means the management of a forest to give equal annual or periodic returns in perpetuity.

Small mills, with an annual output of less than 500,000 board feet, are found scattered throughout the Auckland isthmus, South Waikato, the Volcanic Plateau, the Wairarapa, the Waimea Plain, mid-Canterbury and eastern Southland. Even though sawmills in this class accounted for 320 out of the 635 registered in 1960, they producted only 7.2 per cent of the total timber sawn. These smaller mills are concerned mainly with cutting indigenous species, are located near the actual logging face, and supply a local market. Since most have been long established, machinery is outmoded, and utilization of the forest resource is wasteful. Unsightly piles of slabs, offcuts and sawdust near a building of unpainted boards and rusting corrugated iron are symptomatic of inefficient usage.

TABLE 4.1
SAWMILLING INDUSTRY, 1960.

Number of Mills	Timber Production			
Production in Board Feet	Total	%	Total	%
Under 50,000	102	16.1	2,007	0.3
50,000-100,000	46	7.2	3,392	0.5
100,000-500,000	172	27.1	44,011	6.4
500,000-1,000,000	106	16.7	76,408	11.0
1,000,000-5,000,000	196	30.8	359,580	51.8
5,000,000-10,000,000	8	1.3	56,976	8.2
Over 10,000,000	5	0.8	151,468	21.8
	635	100.0	693,833	100.0

Source: New Zealand Forest Service, Wellington.

In between these two extremes lies a wide range of sawmills. Some of the larger and more efficient of those cutting the few remaining stands of virgin forest are located in the northern King Country, where 14 mills produce 20,000,000 board feet of indigenous timber or 7 per cent of the country's total output[9]. An important post-war trend has been the entry into sawmilling of box-makers, building firms and timber merchants. These firms, interested in ensuring a regular supply of timber, locate their mills so as to be able to work widely separated stands at the same time. With this centralization sawmilling settlements have become less isolated and the problem of attracting mill hands is less acute than it was in the past.

If the advances made by sawmilling since 1945 have been notable, even more spectacular has been the phenomenal growth of other industries processing locally-grown wood. In 1950, the production of pulp, paper, paperboard and fibreboard in New Zealand amounted to 56,751 tons[10]. Ten years

9. D. E. Willoughby: "The Timber Industry of the King Country: Past, Present and Future," Unpublished Manuscript, Auckland, 1960, p. 14.
10. N.Z. Forest Service: "Statistics of the Forests and Forest Industries of New Zealand," Wellington, 1957, Table 14.

later this total had risen almost eight times, to reach 433,981 tons[11]. In the interim, three plants have begun operations at Kinleith and Kawerau in the central North Island. These three enterprises, together with the longer-established concerns at Mataura, Whakatane and Penrose, employ 2,650 workers and produce kraft pulp, newsprint, cardboard, wrapping paper, building paper, toilet tissues, softboard and particle board.

The pulp and paper industry in New Zealand, heavily capitalized, highly mechanized, and employing a skilled work-force, is typical of many industries whose major expansion has occurred during the past decade. It differs from most other industry groups in that the amount of capital invested is greater than the total value of annual production. This year, in fact, the latter is estimated to have reached £10,026,000, or only one-third of the capital outlay of £34,000,000[12]. The plants at Kawerau, Kinleith and Whakatane, which account for 81 per cent of the country's output (Table 4.2), comprise several separate, yet vertically-integrated units in order to reduce wastage of the fibrous raw material to a minimum. Production is continuous and 3 eight-hour shifts are worked in all plants except that at Penrose, near Auckland. Although an average of 440 men are engaged in each of the seven concerns, the actual processing is carried out by a few, highly-skilled employees operating highly automated equipment.

TABLE 4.2

PULP AND PAPER INDUSTRY, 1958**

Company	Location	Date Commenced Operations	Output (tons) 1958	Main Products
Tasman Pulp & Paper	Kawerau	1955	75,000 39,000	Newsprint Sulphate Pulp
N.Z. Forest Products	Kinleith	1952	30,000 70,000	Kraft Paper Sulphate Pulp
N.Z. Forest Products	Penrose	1941	25,000 5,000	Wallboard Multiwall Bags
Whakatane Board Mills	Whakatane	1939	31,000	Cardboard
N.Z. Paper Mills	Mataura	1877	10,000*	Kraft Paper
United Empire Box	Hamilton	1940	6,000*	Kraft Containers
Caxton Paper Mills	Kawerau	1956	4,000*	Sulphite Paper

* Estimated.

** No attempt has been made to average out the figures for a calendar year and the above date (1958) refers to the financial years of the different companies. 1958 is the most recent year for which complete and comparable figures are available.

11. Report of the Director of Forestry, "A.J.H.R.", C-3, 1960, p. 108.

12. W. B. Sutch: New Zealand's Manufacturing Development Since January, 1958, "Proceedings Industrial Development Conference," June, 1960, p. 3.

Despite the importance of the sawmilling and pulp and paper industries, these do not constitute the only types of wood processing in New Zealand. Veneer factories, few in number and small in size, utilize defect-free lumber for the production of veneer and plywood. Both indigenous and exotic logs can be selected as 'peelers', and during the past two years the use of radiata pine has increased.

Though more and more packaging is done in cardboard containers, the fruit-growing and cheese-making industries still provide a steady market for shooks and cases. Many of these mills are found in Nelson, Taranaki and Southland, in addition to the four metropolitan centres, though the larger plants at Waipa, Penrose, Kinleith, Whakatane and Conical Hill operate as part of an integrated concern. Just as in recent years the amount of thinning carried out has risen, so, too, has the sale of minor forest produce become increasingly important. In this way the demand for mine props, fencing battens and telegraph poles is met and the exotic plantations benefit by receiving much-needed silvicultural treatment. In 1958-1959, only 10.6 per cent of the number engaged in all manufacturing throughout New Zealand were employed in forest industries, whilst the added value of goods produced accounted for 14.7 per cent of the New Zealand total[13]. Yet the economic importance of forest industries is even greater than these figures indicate. Overseas earnings during the past five years have averaged £7,000,000 annually and the development of the pulp and paper industry since 1950 has begun the utilization of once-dormant forest resources totalling 450,000 acres. In particular, the overall economic changes of the central North Island and the spectacular transformation around Tokoroa and Kawerau is largely a result of carefully planned and swiftly accomplished forestry development.

INDIGENOUS VERSUS EXOTIC SPECIES

Just as the "boom" plantings of the 1920s and 1930s reflected an awareness of an imminent timber famine, so today restrictions on the milling of indigenous species indicate the dwindling reserves of virgin forest. While 14,470,000 acres of the original cover still remain, only 13.8 per cent of this is merchantable. If demand for native timber rises considerably in the future, a further 810,000 acres in areas of marginal accessibility could be exploited[14]. Most of the remainder is far more valuable in regulating run-off and pre-

13. Dept. of Statistics: "Report on the Industrial Production Statistics of New Zealand, 1957-58," Wellington, 1959.
14. Dept. of Statistics: "New Zealand Official Yearbook, 1960," Wellington, 1960, p. 555.

venting soil erosion. In Westland, for example, 70 per cent of the predominantly rimu and miro stands are located on thin, unstable, skeletal soils. Were this forest cover to be removed, rapid and destructive earth movement would inevitably follow.

Despite the small area still occupied by merchantable stands of indigenous timber, introduced species will never completely replace those which are native to New Zealand. In Northland, scattered pockets of kauri total 16,000 acres[15], stands of rimu and miro in Westland account for 256,500 acres, and various species of beech, notably red and silver beech, occupy 39,000 acres in western Southland. Of necessity, the cutting of such reserves during the next 25 years should become progressively slower, and the lumber extracted put to increasingly specialized uses. By 1975 the estimated output from Westland, undoubtedly New Zealand's most important source of indigenous timber in the future, will amount to only 37,000,000 cubic feet, or one-half the present volume cut[16].

Considerable research is required before the successful management of indigenous species is assured. Recent investigations have shown that kauri regeneration is possible, and that rimu can establish itself where second growth, engendered by selective logging, acts as a nurse cover. Beech regenerates vigorously after felling and it generally occupies sites which are unsuitable for agriculture. Even so, New Zealand must rely increasingly upon exotic species in the future. By the year 2000 it is unlikely that more than 7 per cent of domestic timber requirements will come from indigenous reserves[17]. In 1925 McIntosh Ellis predicted that by 1965 local timber consumption would reach 675,000,000 board feet, of which State-owned coniferous plantations would supply 600,000,000 board feet as against 50,000,000 board feet contributed by indigenous stands[18]. While this forecast of total consumption was remarkably accurate, today virgin forests still supply 48.8 per cent of all timber sawn.

One of the reasons for the continued reliance on indigenous species lies in the quality of the first crop of exotics. Because of the use of poor seed, poor planting techniques (sometimes due to racing between the planting gangs) and inadequate silvicultural treatment, the quality of the exotic forest resource is not as high as might have been possible.

15. This figure excludes the Waipoua forest, a national sanctuary in which logging is prohibited.
16. Ministry of Works: West Coast Region, "National Resources Survey," Wellington, 1959, p. 121.
17. "A.J.H.R.", C-3, 1959, p. 40.
18. First Quinquenniel Review of the Operation of the National Forest Policy, "A.J.H.R.", C-3, 1925, p. 7.

Lack of finance prevented the full implementation of a silvicultural programme. Only one acre in six in Kaingaroa Forest has been pruned and thinned since 1935. Forestry in New Zealand is not yet financially self-supporting and during the past five years one-quarter of the total expenditure has come from State funds. To curtail silvicultural treatment, however, is as wasteful of the country's forest resources as to leave merchantable timber unutilized. The increasing export value of wood products is sufficient justification for increased expenditure on forest care.

Plate VI. Part of Kaingaroa State Forest & Kaingaroa village.

PRESENT UTILIZATION

At 150 cubic feet per acre, the annual increment of 926,000 acres of exotic species in New Zealand amounts to 139,000,000 cubic feet[19]. This volume, at a royalty of threepence per cubic foot, is valued at £1,730,000. In order to fully utilize this increment 27,000 acres per year should be cut, whereas for the 12 months ending March 31, 1960, a mere 3,600 acres were harvested. Fibrous raw material valued at more than £1,500,000 per year remains unutilized.

The Kaingaroa Forest gives some idea of the potential volume of wood which is lying idle throughout New Zealand. In 1950, the sustained yield of this plantation was estimated to be 32,000,000 cubic feet, which, allowing for losses from fungal and insect attack, was sufficient to supply the raw material for 75,000 tons of newsprint, 45,000 tons of sulphate pulp and 72,000,000 board feet of sawn timber. Ten years later it was recognised that the annual increment was at least 40,000,000 cubic feet, or sufficient for an additional 100,000 tons of newsprint. In future, far more accurate assessments of timber volume will be necessary if New Zealand is to make full use of the exotic forest resource.

Again utilization does not necessarily imply efficiency. For convenient management Kaingaroa is divided into three working circles — Waipa (16,000 acres), which, with nearby Whakarewarewa, makes up the north-western sector; Waimihia (35,000 acres), which occupies the southern portion; and Murupara (199,000 acres), which accounts for the remainder. Even though logs cut from the first named are transported to the State mill at Waipa, dumps of rejected lumber contain up to 2,000 cubic feet per acre. This is because Waipa, being a sawmill, will accept only those logs which are straight, free from obvious defects, and more than 18 feet in length.

Clear felling throughout the Murupara Working Circle, on the other hand, is more efficient since all of the lumber cut is consumed in the various processing units at Kawerau. As a result, yields per acre are higher and the financial return per acre harvested considerably greater. With the exotic forest resources of New Zealand likely to be inadequate in the near future, it is illogical that throughout the Waipa Working Circle wastage should occur on such a large scale. Only extensive field study could reveal the extent to which the country's wood crop is being incompletely used elsewhere.

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19. Coniferous species in New Zealand grow at a much faster rate than in the Northern Hemisphere. At 25 years, well-stocked stands of radiata pine yield up to 8,000 cubic feet per acre, as against 5,300 cubic feet on the Pacific Coast of North America.

Within the next 15 years, the elimination of inefficient methods of utilization, together with a greater amount of silvicultural care, should increase the output of exotic timber considerably. This achieved, research could begin on several important problems which to date have received little attention.

Though few of the exotic forests of New Zealand have been established for more than 40 years, in local areas the effect of introduced species upon soil texture and soil colour has already become apparent. That a relationship exists between tree growth and soil fertility is indisputable, but until more detailed research has been carried out the forester cannot be certain which species are best suited to a particular soil type. Already observations have been made in the Kaingaroa Forest in an attempt to trace those soil changes which occur with the increasing age of a plantation. Only when the results of such research are available, are the exotic forests of New Zealand likely to produce a yield commensurate with their areal extent.

THE FUTURE SUPPLY

No matter how successful conservationist measures are in the near future, New Zealand faces a prospective timber famine within the next generation. By 1985, the present surplus of timber from coniferous plantations will have disappeared[20], as a result of the increasing use of wood as an industrial raw material and of the rising local demand consequent upon population increase.

With a projected population of 4,875,000 in New Zealand by the year 2000, 90 per cent of the wood requirements for sawn timber, pulp, plywood, posts and poles will have to be met from exotic species. Present North Island plantations, however, will be able to supply only 110,000,000 cubic feet of an estimated demand for 150,000,000 cubic feet, while those in the South Island are unlikely to have a surplus above local requirements. If the annual increment of exotic species is taken as 150 cubic feet per acre, the afforested area will have to be extended by a further 200,000 acres by the end of this century in order to meet domestic requirements[21].

The income derived from the export of newsprint, sulphate pulp, kraft paper and kiln-dried timber since 1953 has demonstrated the importance of the processing of wood products to the economy of New Zealand. For the next 40 years,

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20. "A.J.H.R.", C-3, 1960, p. 17.

21. A. R. Entrican and M. B. Grainger: "Farm Forestry and the Forward Timber Position," Paper Presented to Combined Farm Foresters' Conference, Massey College, May, 1958, p. 2.

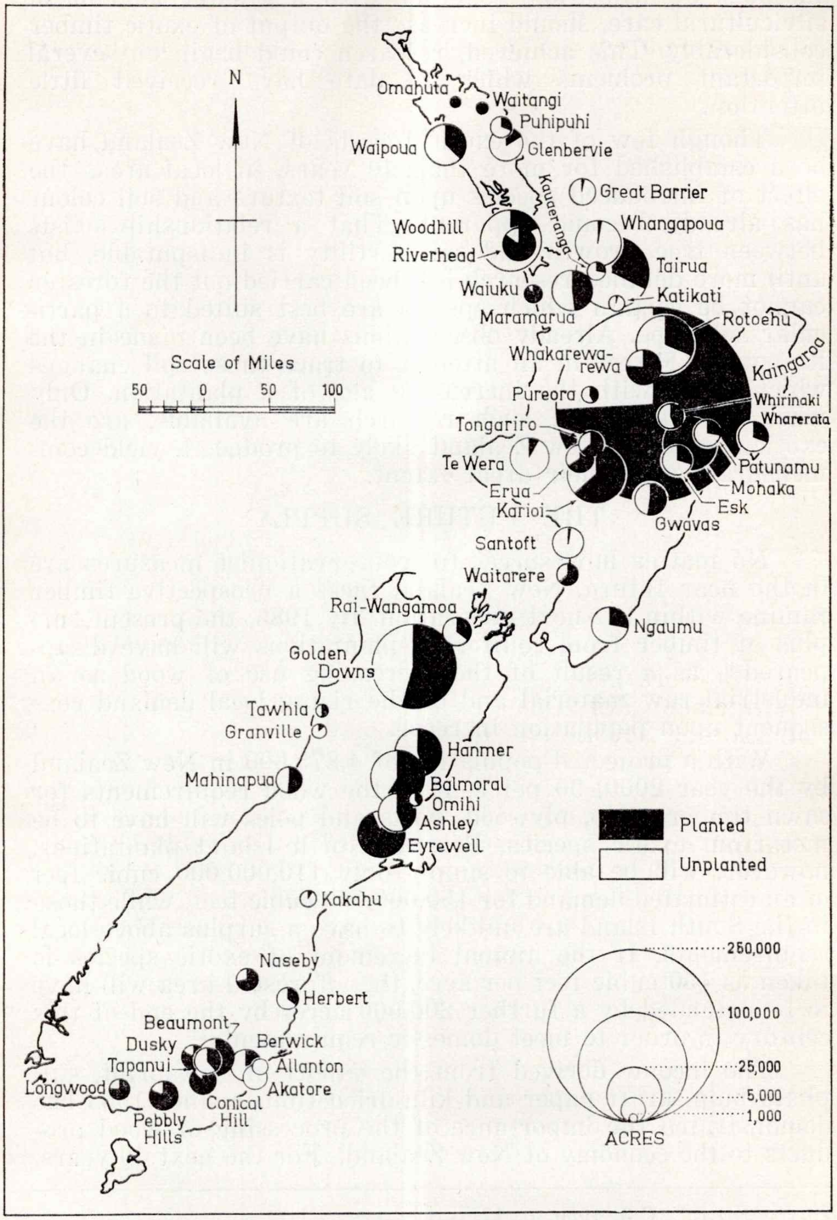

Fig. 4.2. State exotic forest showing planted & unplanted area. (Source: "A.J.H.R.", C-3, 1960, p. 70f.).

it seems likely that an overseas market exists for the equivalent of 50,000,000 cubic feet of timber, compared with the 30,000,000 so consumed today. Add this to the future deficit of 30,000,000 cubic feet in the North Island, and the area required to be planted to exotic species rises by 200,000 acres to 530,000 acres. If, as the Forest Service suggests, exports will absorb 150,000,000 cubic feet by the year 2025[22], then the area to be afforested increases to a phenomenal 2,000,000 acres.

FORESTS AND FARMS

Of the area at present gazetted as exotic forest, only 46.3 per cent is planted with trees (FIG. 4.2). It is inevitable, therefore, that afforestation in the near future will be directed at replacement of the fern, scrub and tussock in the remaining 53.7 per cent. But so great will be the future demand for lumber that even the consolidation of exotic plantations will be inadequate. Forestry can justifiably lay some claim to those few parts of New Zealand where large blocks of suitable land are available — to the gumlands of Northland, the pumice country of the central North Island, and the better Moutere soils of the Nelson district.

Some claim, however, does not mean pre-emptive claim. Many of these unfarmed areas are suitable for dairying or mixed farming. Nor would it be desirable to repeat the mistake of the 1920s when thousands of acres on the Volcanic Plateau were planted to conifers with little thought of the management difficulties that were being created. A combination of forest and farm would be preferable — blocks of pine trees broken at regular intervals by farm holdings which would occupy the better-quality land. In this way, the most profitable use could be made of the undeveloped areas of New Zealand, and each method of land utilization would be located on land well suited to its requirements.

Districts where intensive pastoralism has long been established could also benefit from the combination of forestry and farming, as the trees planted to counter the prevailing nor'wester of the Canterbury Plains witness. As in other farming areas, these constitute a source of farm timber, even though little thought was given to this possibility when they were first established. Existing shelterbelts, however, are not always sited to optimum effect. Frequently they are too sparsely distributed, whilst the quality of the trees gives indifferent shelter and, ultimately, poor timber.

Today's shelterbelts are predominantly of radiata pine, but eucalypts and a heavily-foliaged species such as the

22. "A.J.H.R.", C-3, 1960, p. 18.

cypress (which provides ground-level shelter), would prove a better source of firewood and fencing battens. Species such as the brown barrel (Eucalyptus fastigata), the alpine ash (Eucalyptus gigantea) and the mountain ash (Eucalyptus regnans) are known to thrive in pumice soils and to resist frosts of up to 18°F., and these would be suitable for the central North Island. Others, such as manna gum (Eucalyptus viminalis), which have succeeded on dredge trailings, are a more likely proposition for the gravel-strewn Canterbury Plains. At the same time, the introduction of these species must be tempered by the recognition of their slower rate of growth compared with radiata pine.

On many farms, small plots of land remain unutilized for one reason or another. These patches would be better converted to woodlots of short-rotation species, particularly radiata pine, providing the owner with an additional source of income, and also making available for either sawmilling or wood processing industries lumber at present consumed for farm use. The remission of death duties on farm woodlots, announced in the 1960 budget, is one of several ways in which greater participation in farm forestry can be encouraged.

Within the next 40 years, farm forestry is expected to provide an additional 500,000 cubic feet of timber[23], a target unlikely to be attained if wasteland in farmed areas is not immediately afforested. That the need for this is becoming more widely recognised is seen in the fact that since 1957 the number of farm forestry associations in New Zealand has risen from 5 to 22. As long ago as 1924 one farmer was deriving £1,200 each year from 100 acres of radiata pine which had been planted on poor land 40 years previously. Up to 8,300 cubic feet was taken from every acre[24], or about the same volume now being cut from staggered settings[25] in the Murupara Working Circle. If species were carefully selected, systematically tended, regularly thinned for firewood and fencing battens, and felled in a 40-year rotation, land at present lying waste would be put to economic use. In the future, forestry and farming will have to be acknowledged in New Zealand as complementary pursuits; today, they are regarded as rival claimants to the same land.

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23. A. R. Entrican: The Forest Resources of New Zealand, "Record," No. 29, January-June, 1960, p. 4.

24. N.Z. Forest Service: "Forests and Forestry in New Zealand, 1923," Presented to the Imperial Forestry Conference, Ottawa, 1923, Wellington, 1923, p. 24.

25. Settings are areas which have been selected for clear felling. Normally these are not located adjacent to parts of the forest cut previously, hence the term staggered settings.

DEVELOPMENT OF FOREST INDUSTRIES

With the increase in the output of newsprint and kraft pulp in New Zealand, a lucrative export trade with Australia has grown up, much-needed overseas revenue has been gained, and a little more diversity has been added to an economy too heavily dependent on grassland farming. Since 1955, even allowing for the effects of import control[26], the value of trade in wood products compared with total trade between Australia and New Zealand, has risen from 31 to 55 per cent. This represents a gain of almost £4,000,000 in the value of wood products sold each year.

TABLE 4.3
EXPORTS OF WOODPULP, NEWSPRINT AND SAWN TIMBER TO AUSTRALIA, 1955 - 1958.
(By £NZ value)

Year	Woodpulp	Newsprint	Sawn Timber	Wood Products as % of Total Trade
1955	1,038,078	21,524	1,043,223	31
1956	1,494,294	1,525,641	870,684	46
1957	1,824,118	2,169,347	785,244	47
1958	2,036,899	2,627,944	1,029,482	55

Sources: Dept. of Statistics: "External Trade, 1957," Wellington, 1959, p. 41f. Dept. of Statistics: "New Zealand Official Yearbook, 1960," Wellington, 1960.

In 1957, overseas earnings from the Tasman mill at Kawerau alone reached £4,300,000, whilst sale of locally-produced newsprint within New Zealand represented a further saving of £1,700,000[27]. Today, it would appear that the total amount directly earned and indirectly saved from the products of this one concern is near £9,000,000.

Nor is the output of wood products in the near future likely to remain static. Expansion in an industry as heavily capitalized as that concerned with the production of pulp and paper, normally takes several years to plan, and New Zealand is no exception. Within the next five years four major developments are projected and a fifth is a definite possibility.

Plans for the expansion of the Tasman mill were announced in September, 1959. By 1965, the production of newsprint will have risen from 75,000 to 180,000 tons, and the increased exports, mainly to Australia, will net an additional £1,000,000 annually. At Kinleith, expansion on a comparable scale will increase the output of kraft paper by 30,000 tons. In the case of the two smaller mills at Whakatane and Mataura, production of paperboard and kraft paper is expected to rise by approximately 30,000 tons. It is likely, too,

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26. Total imports from Australia in 1959 were valued at £37,140,000 or 15 per cent lower than for the previous year. (Dept. of Statistics: "Abstract of Statistics, May, 1960," Wellington, 1960, p. 36).
27. "A.J.H.R.", C-3, 1958, p. 91.

that the next five years will see the establishment of a second pulp and paper plant in the South Island, either at Nelson or in Canterbury, with a capacity of about 40,000 tons.

For the future, as for the present, expansion will be governed by the overseas demand. In New Zealand the per capita consumption of newsprint, at 62lb, ranks third to that of the United States and Australia[28]. If population projections are taken as a basis, it is unlikely that local demand will rise more than an additional 10 lb per person by the turn of the century. It is in the export market, therefore, that the future potential for newsprint lies. Important prospects exist in Southeast Asia, where literacy is increasing and standards of living are slowly rising.

Australia, with its rapidly growing population, will continue to be a major consumer of New Zealand-produced newsprint and kraft pulp. Between 1939 and 1958, the Australian per capita consumption of newsprint rose almost 10 lb to reach 64 lb, whilst the 81,000 tons produced by local plants in 1958 accounted for less than one-third of the total tonnage of newsprint used. Nor can there be any appreciable increase in the amount of short-fibred pulp[29] produced within Australia, since the "quantity [of radiata pine] available to any one locality is small in relation to local pulping requirements."[30] Even though the Australian Paper Mills have planted 19,700 acres in pine since 1950, this company is likely to remain the major importer of kraft pulp from New Zealand. In fact, it is uncertain whether the afforestation undertaken to date has been sufficiently extensive to meet the growing timber requirements of Australia, let alone supply her conversion units with pulpwood.

Despite the fluctuations of a highly-competitive world market, it appears certain that there will be a steady demand in the future for newsprint and sulphate pulp manufactured in New Zealand. At the same time processing will undoubtedly progress beyond the systematic utilization of a locally-grown wood crop. With the large amount of capital invested in the vertically-integrated plants at Kinleith, Kawerau, Penrose and Whakatane, it would seem strange if the second stage — the use of now wasted materials and the recovery of the more obvious by-products — did not begin within the next 10 years. One ton of logs, for instance, converts to one-fifth of a ton of

28. M. B. Grainger: "New Zealand's Future Wood Resources and Requirements," Appendix to Item 5, Asia-Pacific Forestry Commission, FAO, New Delhi, February, 1960, p. 5.
29. Since eucalypts are the main species used in Australia, most of the pulp is long-fibred, compared with New Zealand pulp made from radiata pine which is short-fibred.
30. Aust. Dept. of Trade: "The Australian Pulp and Paper Industry," Report Presented to Fourth Regional Conference, FAO, Tokyo, October, 1958, p. 5.

sulphate pulp and from the four-fifths which remain a number of other products are recoverable.

In parts of America a considerable proportion of wood pulp is consumed in the manufacture of rayon. Because of the highly-resinous nature of Pinus species, sulphite pulp, upon which rayon processing is based, is not made in New Zealand. Ten years ago Entrican put this forward as an argument against the establishment of a rayon mill in New Zealand[31]. In 1953, however, a plant began production in the United States which utilizes Southern Yellow pine, the physical characteristics of which are similar to those of radiata pine. The recent announcement (November, 1960) that a rayon mill is to be established in New Zealand shows this to be a technical development which is adaptable to local conditions. With the construction of such a plant a whole field of wood chemistry is opened up, for similar processes are used in the manufacture of explosives and photographic film.

A further possibility is laminated timber made from lower grades of lumber, a product which commands a ready market overseas. If this process were more widely adopted in New Zealand, the country would have little need to import structural timber. Similarly, during the past 12 months the spectacular rise in the use of a locally-made particle board reflects its versatility compared with the fibreboard produced since 1940 at Penrose. Within the next 15 years it is estimated that domestic consumption of particle board will rise to 17,000 tons, or half that of fibreboard[32]. Should this occur, much of the sawdust and low-grade timber at present wasted would be utilized.

Nor with the recent development of heavy industry throughout New Zealand is there any reason why turpentine or oleo-resin should not be extracted from pine stumps and wastewood, as is done in the United States. It would be an interesting, if academic, exercise to estimate the potential amount of wood chemicals which lie unused in the unsightly dumps of lumber found throughout the recently-cut stands of the Waipa Working Circle.

THE NEXT CROP

Since the early 1920s, the progress of forestry and forest industries in New Zealand has been favoured by circumstance. It was fortuitous that radiata pine, Douglas fir and Corsican pine pit-planted by private individuals and prison labour should have grown so rapidly on land which, in

31. A. R. Entrican: Quality versus Quantity in New Zealand Forestry and Forests Products, "N.Z. Journ. Forestry," Vol. 6, No. 2, 1950, pp. 100-110.
32. Grainger: op. cit., p. 5.

general, had been spurned by the pastoralist. It was fortuitous, too, that a nation-wide depression should permit an exceptionally large concentration of labour to plant young pines at a time when it was realized that the existing forest area could not meet future timber requirements. Today, this luck is continuing. Despite the predominance of a single species, the even-aged nature of the wood crop, the use of suspect provenances, and the lack of much-needed silvicultural treatment, logs drawn from plantations in the central North Island convert to a newsprint which is known overseas for its strength and good printing qualities.

In the future, the continued development of forestry and forest industries cannot be based upon such chance circumstances. Detailed, systematic planning is imperative if the last remnants of the country's once-magnificent indigenous cover are to be used in perpetuity. Careful control and supervision of logging by the New Zealand Forest Service and research into the regeneration of indigenous species should ensure that reserves will be adequate for many years, though at a somewhat reduced rate of consumption.

Clearly, the future of New Zealand forestry depends largely upon the continued growth and efficient utilization of the exotic pine. With the second rotation reached in only the earliest established plantations, it has yet to be proved conclusively that species planted and silvicultural programmes followed are best suited to local conditions. It may be that longer-rotation species such as Douglas fir and Corsican pine will be planted for high-grade building timber in preference to radiata pine, which, in turn, may be regarded as a catch crop for pulpwood.

But whatever the future species composition of the exotic forests of New Zealand, and whatever the methods by which they are tended, the country cannot afford a repetition of the mistakes of the past century. Even though wood can never be so important a crop as grass in New Zealand, such developments as those outlined would diversify the Dominion's economy. The words of Theodore Roosevelt are as applicable to New Zealand today as they were to the United States 50 years ago:

> The fundamental idea of forestry is the perpetuity of forests by use. Forest protection is not an end of itself: it is a means to increase and sustain the resources of our country and the industries which depend on them.

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33. Pit planting is a method of planting nursery stock in which the young trees are placed in pits about 10 inches deep. Trees planted by this method at the rate of 400 per day during the early 1920s had a better chance of survival than those established by notch-planting 10 years later.

THE IRON AND STEEL INDUSTRY OF N.Z.

J. S. Watt, D.Phil., M.Sc.*

Up to the present time the iron and steel industry of New Zealand has been essentially concerned with making steel structures, fabricating reinforcing steel, and manufacturing plant, equipment and consumer goods from imported sections, rods, sheet, plate and other forms. A small rolling mill operated in Dunedin for a period rolling bars and light sections from imported billets, but it finally had to close down because it could not compete economically with imported finished products.

Several attempts have been made to smelt ironsands in the past, but all have failed. A summary of these attempts has been given by W. R. B. Martin[1] and I do not propose to go over that ground again in this present paper.

I feel that the main interest today is not in the past but in the future. Is a steel industry based on ironsands likely to be practicable, and, if so, what form will it take? The government has just established a company to go into these problems and to find answers to those questions. I do not wish to anticipate their findings in any way, but I would like to state the known facts, to point out what technical and economic data are still required and to narrow down the possibilities. Later in this paper I shall discuss the merchant bar mill at present being erected at Otahuhu to produce bar products using New Zealand's own scrap arisings as raw materials. This represents the first phase of the establishment of a comprehensive iron and steel industry in New Zealand.

THE MARKET

Steel is used in New Zealand in a wide range of applications and an examination of the usage in the past reveals some interesting facts. The graph (Fig. 5.1) shows the

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1. Martin, W. R. B., The Iron and Titanium Ores of New Zealand, . . . "New Zealand Engineering," Vol. 10, No. 10, 1955, p. 317ff.

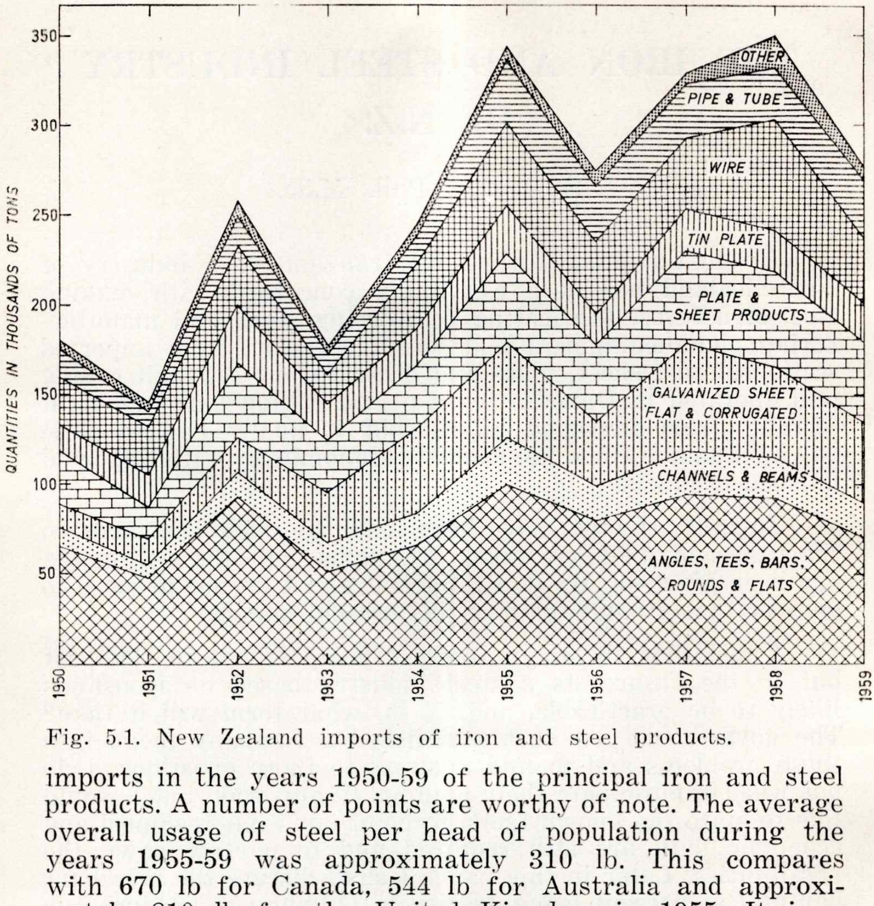

Fig. 5.1. New Zealand imports of iron and steel products.

imports in the years 1950-59 of the principal iron and steel products. A number of points are worthy of note. The average overall usage of steel per head of population during the years 1955-59 was approximately 310 lb. This compares with 670 lb for Canada, 544 lb for Australia and approximately 810 lb for the United Kingdom in 1955. It is a reasonable assumption, therefore, that steel consumption per head of population in New Zealand will increase as the country becomes more industrialized. For comparison, Australia's per capita usage increased from 390 lb in 1950 to 544 lb in 1955, and 710 lb in 1958, and Britain's from around 400 lb in 1935 to 810 lb in 1955.

As a result of periodic restriction and easing of import and financial controls, annual imports have fluctuated violently but overall consumption of iron and steel products has risen by about 50 per cent every five years. This means that, barring unforeseen circumstances, the average annual usage for the five years 1960-64 can be expected to be about 450,000 tons; for the years 1965-69 about 675,000 tons per year; and before 1975 the annual usage could reach 1,000,000 tons per

year. Based on the population projection for 1975 this would represent a usage per head of population of over 700 lb. This may seem a very large increase over the 310 lb average for 1955-59, but when it is compared with the recent increases in Australia and other countries, it does not seem at all impossible, particularly in the light of the plans for increased production. By 1975 it is probable that 700 lb per head of population will be a very modest rate of usage.

The pattern of usage is somewhat unusual. Heavy structural forms represent only a very small part of the usage. Merchant bar products, the name usually given to angles and tees, rounds, flats, bars and similar sections, represent the biggest single group, but wire products, galvanised sheet and tinplate also represent a considerable percentage. This results from our predominantly grassland farming which utilizes a great deal of wire fencing; from the popularity of corrugated galvanized iron roofing; and from our relatively large canning industry. In fact, if heavy structurals and heavy plate, which are not likely to warrant manufacture for a very long time to come, are excluded, a very high percentage of the remaining sections are used in sufficient quantity to justify manufacture once a smelting industry is established.

The products fall into two main groups. The first covers merchant bar products, wire rod, medium sections and narrow strip or skelp for pipes, and the second, plate and sheet products. These two groups require quite different types of rolling mills for their production and can be developed more or less independently of each other.

It is not possible from the normal government statistics to get an accurate picture of the distribution of steel products throughout New Zealand and, indeed, with the changing pattern of usage it is hardly worthwhile attempting to get an accurate picture of the past. However, from all available data it appears that, overall, the distribution of steel follows the normal pattern of business in New Zealand so that about 44 per cent is sold in the Auckland province; about 30 per cent in the remainder of the North Island; and about 26 per cent in the South Island.

RAW MATERIALS

The basic raw materials for the production of iron and steel are iron ore and a reducing agent. The usual reducing agent is coke or charcoal, although it is possible to use a gaseous reducing agent consisting of hydrogen or a mixture of hydrogen and carbon monoxide. These gases can be obtained from coal, wood, petroleum or natural gas. Production of charcoal from wood is too expensive and so, until

petroleum or natural gas is found in quantity in New Zealand, there is no economic alternative to coal as the source of the reducing agent. New Zealand has a shortage of the bituminous coking coals which are essential for the production of pig iron in blast furnaces. Therefore, either we must use coal imported from say Australia, or we must use a process which can make use of the sub-bituminous coals of which we have quite considerable reserves. As will be shown below, there are now a number of alternative processes for the reduction of iron ores which can make use of these New Zealand coals. If, therefore, any of these processes prove technically and economically satisfactory for the smelting of our New Zealand ironsands, then it can be taken that we have adequate coal reserves to support an iron and steel industry. The prospects that one or other of these so-called "direct reduction" processes will prove suitable are very promising.

New Zealand is badly off for what might be called "conventional" iron ores, the only deposit of any size being the Onekaka limonite deposit which, however, has been shown to be much too small to support an iron and steel industry. We have, however, very considerable deposits of ironsands, particularly on the west coast of the North Island from Wanganui in the south to Muriwai in the north. (See Fig. 1.3, p. 11). In addition there are substantial deposits of ilmenite sands on the West Coast of the South Island. Ilmenite is a compound of iron and titanium. There have been no detailed surveys of these deposits, but the Department of Scientific and Industrial Research has made exploratory surveys of all the potential deposits and Fletcher Holdings Limited and Kaiser Engineers have made a somewhat fuller survey of the more promising areas. Indications from this work are that there are thousands of millions of tons of iron-bearing sands containing several hundred million tons of elemental iron. The reserves can, therefore, be considered more than adequate from the point of view of volume. From a technical point of view, there are far too many gaps in our knowledge both of the quantity of sand in the known deposits and the iron content of the sands. One of the tasks of the investigating company and, in my view, probably the most important, is to see that this detailed geological information is obtained. A precise knowledge of the quantity and location of the ore reserves available and the chemical and physical analysis of the reserves is a first essential to the establishment of an industry.

Other raw materials such as fluxes and metallic additives are of minor importance even if it is necessary to import them. Processing materials such as limestone, dolomite, fluorspar, and others will be required and some of these will also

need to be imported, as will some special refractories and furnace electrodes.

SERVICES

The main services required are electric power, fuel for ingot and billet reheating furnaces, and cooling water. The power requirements vary with the type of process and the end-product but are not excessive for any of the likely processes. This aspect of the problem will be discussed more fully in a later section. Reheating furnaces can be fired with natural gas, producer gas, coke oven gas or fuel oil. Some of the possible processes produce a suitable gas as a by-product, but the more promising processes would require producer gas or fuel oil firing. Of these, the latter is the more efficient heating medium. Steel works are large users of cooling water and should have adequate supplies readily available. In many cases a closed circuit recirculation system with a makeup of fresh water is used.

From the foregoing, we see that the pre-requisites for the establishment of an iron and steel industry in New Zealand seem to be satisfied. We appear to have adequate supplies of ore and reducing agent and the necessary services. Usage has reached a sufficient magnitude to warrant local manufacture and it is growing at a rate which would require a steady expansion of facilities to meet the extra demand—a situation which makes for favourable industrial development.

Two important factors must be considered and evaluated before a decision to proceed can be taken. The first is the availability of technical processes suitable for the utilization of the indigenous raw materials and the second whether the products can be produced and sold economically.

POTENTIAL TECHNICAL PROCESSES

In the manufacture of iron and steel products there are basically three processes: the conversion of the ore to essentially metallic iron (smelting); the conversion of this crude metal into steel by adjustment of minor constituents such as carbon, silicon, or manganese; and the working of the steel into finished or semi-finished products for the use of industry by rolling, casting and similar methods. Once the ore has been converted to a crude iron metal meeting certain specifications, particularly with regard to certain impurities, the two subsequent steps are the same as those carried out universally. In other words, there are fully-established processes for carrying out the second and third stages once the first has been achieved. The technical problems to be solved before a steel industry can be based on New Zealand ironsands all lie in the smelting stage.

The form of the ore in the North Island ironsands is titanomagnetite. This is a magnetite (Fe_3O_4) in which some of the iron has been replaced by titanium in such a way that it can be removed only by chemical separation. The titanomagnetite is strongly magnetic and can be readily separated from associated gangue material by magnetic or gravity methods or a combination of the two. From this physical separation a concentrate is obtained containing 55-60 per cent elemental iron and 7-8 per cent titanium dioxide. This concentrate would be the raw material in a smelting process.

Many attempts to smelt New Zealand titanomagnetite have been made and have failed, mainly because of the presence of the titanium. This caused blockages in the conventional blast furnace and it was only after electric smelting in arc furnaces had been developed that the first successful smelting of titaniferous ores was made. However, power requirements for straight electric-furnace smelting are high and methods have been developed over the last few years to reduce this power consumption so that at the present time there is available an electric-furnace process which looks very promising for the smelting of our titanomagnetite. At the same time a number of new processes have been developed which have satisfactorily processed ores similar to New Zealand ores and must certainly come under consideration. The following sections give a brief description of some smelting processes and indicate their strong and weak points.

Previous attempts to smelt titaniferous ironsands in blast furnaces failed because a high melting compound of titanium, a carbonitride, separated as a solid from the slag and finally choked the furnace. When the U.S.S.R. opened its doors to Western steelmakers in recent years it was discovered that titaniferous ores have been smelted successfully in blast furnaces in Russia for some 15 years. Recent work in the United States has also established the conditions under which this can be done. The blast furnace must be operated under acid slag conditions, in which there is a much higher silica ratio than normal, and only moderate temperature since excessive temperatures favour titanium carbide and carbonitride formation. It therefore appears that there is no fundamental reason why New Zealand ironsands should not be smelted in a blast furnace. There is, however, still a major obstacle to the use of this process in New Zealand in the lack of a suitable coking coal. We have virtually no coals from which a satisfactory blast furnace coke can be made, and therefore, in spite of the technical advances mentioned above, blast furnace smelting is still not feasible for New Zealand.

The "Krupp-Renn" process involves reduction of the ore in a rotary kiln and has been used mainly for the smelting of

low-grade ores and/or low-grade fuels. Samples of New Zealand ironsands were sent to Krupps who carried out a series of preliminary tests and reported back that there were some difficulties in the application of their process and that it might be necessary to use incompletely concentrated sands in order to provide adequate slagging materials. As this would increase fuel usage and complicate the separation stages, it greatly reduces the attractiveness of this process, particularly in relation to other processes since developed.

The electric furnace reduction process involves the reduction of the ore by coal or char in an electric arc furnace with the heat required being supplied by electric power. A modification to this process introduces, prior to the electric furnace, a pre-reduction kiln where the ore is partially reduced before entering the kiln. The heat is supplied in this kiln by burning coal or char. This modification has been developed by the Norwegian firm of Elektrokemisk and the American firm of Strategic Materials Corporation and an agreement has now been reached between these two firms to develop their processes jointly. Claims for the "Strategic-Udy" process are that using a high grade ore of similar iron content to the New Zealand ironsands concentrate, pre-reduction with coal in the kiln can reduce the power consumption to 1,120 kWh per long ton of molten metal. If this power consumption can be achieved with New Zealand ironsands, then the process would have considerable attractions. The presence of the titanium oxide in the New Zealand ore may, however, affect the slag composition and amounts and testing of the process with New Zealand raw materials would be essential to establish reliable usage figures.

A proposal by the Nisso Steel Manufacturing Co. Ltd. of Japan for the production of steel by an electric furnace process has also been investigated. Preliminary discussions showed that, although they have had operating experience on small furnaces using Japanese titaniferous sands, their process appears inferior, for our circumstances, to the Elektrokemisk and Strategic-Udy processes. Their process is a straightforward electric furnace reduction with a power usage of 2,400-2,500 kWh per long ton.

In recent years a number of processes have been developed for the reduction of iron ores using gaseous reducing agents, particularly natural gas and reducing gases from petroleum or coal. There are in all some eight processes of this nature but the most important from the standpoint of New Zealand ironsands reduction appears to be the "Esso-Little" process. This was developed jointly by Standard Oil and the research firm of A. D. Little Inc. and is a development of the fluidised bed techniques used by Standard for catalytic reaction in

petroleum refining. The process consists of the generation of a mixture of hydrogen and carbon monoxide from organic fuels such as petroleum, methane, natural gas and coal. While the plant required will vary with the source of the fuel, the reduction stage is the same in each case. The hot reducing gases are passed upwards continuously through a fluidized bed of the finely-divided ore and the latter is reduced to finely-divided iron. An excess of gas is used and the off gas is of similar calorific value to blast furnace gas and could be used in a steel works for similar purposes.

The reduced solids withdrawn from the plant consist of finely divided (sponge) iron with which is mixed the unreduced gangue materials from the ore. These can be separated magnetically to give a product containing approximately 90 per cent iron. The process has so far only been proved on a pilot plant scale and until a production scale plant is available, large-scale tests are not possible. It is understood that Esso-Little intend to build such a unit in the near future but it certainly has not reached the stage of development of the Strategic-Udy and the "R-N" process for example. It has the attraction of requiring finely-divided ore and the New Zealand ironsands are already in a suitably finely-divided state.

Carbon reduction processes differ from the above in that the reducing agent is carbon in the form of coal or coke. The Krupp-Renn process already mentioned comes into this category as does the traditional blast furnace process. The only other process which appears at the present time to have interest for the reduction of New Zealand ironsands is the R-N process. It has been developed jointly by Republic Steel and National Lead and has been extensively tested on a full scale pilot plant. Mainly through the efforts of Mason Brothers Ltd., the suitability of this process for New Zealand ironsands has been extensively examined. The small-scale test reductions carried out so far were very promising and the method would seem, on present evidence, to be suitable for New Zealand conditions. The process consists in pelletizing the ironsands concentrate with certain chemical additives and then passing the pellets through a rotary kiln with an excess of coal, char or coke. Reduction of about 95 per cent of the magnetite to metallic iron takes place with the titanium oxide virtually unreduced. The chemical additives cause the iron to be produced in a physical form which makes its separation from the gangue materials much easier. This separation is effected by wet grinding the kiln product in several stages with a magnetic separation between grindings. Excess carbon is separated prior to the grinding and is recovered for re-use in the kiln. After separation the metallic iron, which is in a finely-

divided form as a slurry with water, is filtered, dried and briquetted into a form suitable for feeding to steel-making furnaces. When using high-grade ores with similar iron contents to New Zealand ironsands, briquettes with over 90 per cent iron have been obtained and these have been shown to be a very suitable feed with scrap steel for electric furnace steel production.

This process has been well-tested using a kiln of 9 feet in diameter and 150 feet in length and therefore it has been proved on a full-scale basis. In fact, if desired, a commercial scale test could be carried out on New Zealand ironsands and coal as soon as the raw materials could be assembled. The briquettes from such a plant would have a wide field of application overseas, particularly in steel mills without a source of hot metal. There are many of these in the United States which operate on scrap only or a scrap-pig iron mixture. The price that would be paid for these briquettes would vary according to the international price of scrap, but it may be possible to negotiate long-term contracts at steady prices.

SUMMARY OF SMELTING PROCESSES

Even though conditions for smelting titaniferous ores in a blast furnace have been established, the lack of adequate coking coals rules out the possibility of using a blast furnace in New Zealand. Although there are a number of so-called "direct reduction" processes which might prove suitable technically and economically for smelting New Zealand ironsands, only a few have been developed to the stage of full-stage trial. Those of interest to us are the Strategic-Udy (and Elecktrokemisk) "Electric Furnace plus pre-reduction kiln process" and the R-N process. Plant is available overseas to carry out large-scale tests using New Zealand ironsands and coals for both these processes, and more data appears essential before a decision can be made on the relative economics of the two processes.

In trying to select the best available smelting process, it is necessary to narrow the range by exhaustive examination economically and by small scale testing, so that probable yields and efficiencies can be established and the chemical composition of the pig iron or semi-steel determined. Ideally this would place the various processes in descending order of merit so that one process would clearly stand out as the best overall economically and technically. This is important as the final stage in the selection would involve the large-scale testing of New Zealand ore and New Zealand coal in a full-scale plant overseas by the chosen method. This test would involve at least several hundred tons of ore and coal and the total cost of obtaining and transporting the raw materials

and running the tests might well reach £100,000. It is, therefore, very important to eliminate, if possible, all processes but one in the preliminary examination so that the expensive large-scale tests do not need duplication.

THE ECONOMICS OF STEEL PRODUCTION

The economics of steel production is a very complicated problem which cannot be dealt with in detail in a paper such as this. A great deal of work has been done on this subject and certain tentative conclusions can be drawn. The following account summarizes the main points of the problem.

Steel products come into New Zealand from a number of different sources and at different prices. Australian steel is the cheapest, but its general availability is variable depending on the demands of the Australian market. British steel companies have been the largest suppliers of the New Zealand market at landed prices which are generally higher than Australian landed prices. In considering, therefore, whether steel products can be produced economically here, the standard of comparison should not be Australian landed prices but either British landed prices or some intermediate figure related to the relative imports over a period. If either of these standards is used, then preliminary calculations indicate that ingot steel could be produced here at prices which would enable a number of rolled products to be manufactured economically in spite of the disability a local mill would have due to the high cost of distribution within New Zealand. This disability is largely avoided by an overseas supplier who can ship to all main ports for the same cost.

The two smelting processes which at the present look most promising, the Electrokemisk/Strategic-Udy and the R-N process can both operate economically at low tonnages. The basic unit for full-scale operation is of the order of 100,000 tons in each case. This means that, if desired, the industry can be built up in stages and the capital expenditure spread out over a period of years. For example, the merchant bar mill at present being erected by Pacific Steel will have a total capacity of some 120,000 tons per year on three-shift working, but will have raw material (local scrap) for only about 50,000 tons. Further, by relatively minor additions the mill could make wire rod and pipe skelp, the starting points for wire and pipes respectively, in addition to merchant bars. The total present usage in these three lines is about 150,000 tons per year which equals the estimated scrap arisings in New Zealand plus the metal from one unit of either a Strategic-Udy or an R-N plant.

The siting of the mills is an economic problem and should be solved on this basis. I do not propose to nominate my choice

of site, if indeed I have a chosen site, but would like to point out a few facts which must have a major bearing on the selection. The main bodies of ore are located in the North Island between Wanganui and Muriwai. (See Fig. 1.3, p. 11.) While Lake Taharoa appears to be the largest deposit, there are substantial deposits at Raglan, Waikato Heads, Manukau Heads and Muriwai to the north and smaller and more widespread but still substantial deposits mainly in Taranaki stretching from Marokopa to Wanganui in the south. As already stated, these deposits have yet to be adequately proved in detail, but it is fairly certain that the above represents the general picture.

The best proven deposits of coal are in the Waikato and the next in the Ohai field of Southland. The Benhar field of Otago has not been proved, although it is thought to be a very large deposit. From analyses of samples taken from the mine face Benhar coal appears to fall into the class of black lignites with a calorific value of about 7,500 B.t.u. per lb compared with Waikato coals of over 10,000 B.t.u. It would normally be considered unsuitable for smelting unless converted to char first and char has not yet been made from it commercially, whereas Waikato coals have been used for char manufacture for many years.

Using the Strategic-Udy process, the heavier power user of the two preferred processes, the power requirements per ton of ingot steel have been estimated at about 1,600 kWh, and per ton of rolled bar products about 2,000 kWh. Each increase of 0.1d. per kWh therefore represents an increase in the cost of finished product of 16s. 8d. per ton. If we take the cost of transmission of power from Benmore to the middle of the North Island as 0.2d. per kWh, the maximum extra cost for power on the production of rolled products between a South Island and a North Island site would be £1 13s. 4d. per ton. This assumes the worst case in which no power is available from North Island stations.

Present freight rates on steel between the North Island and the South Island are over £5 per ton. For a plant in the North Island inter-island freight on products would cost approximately 0.25 x £5 or £1 5s. 0d. per ton of steel produced. For a South Island plant, inter-island freight on products would be 0.75 x £5 or £3 15s. 0d. per ton. The extra cost of distribution of products for a South Island plant would therefore be £2 10s. 0d. per ton, considerably more than the cost of transferring power from the South Island to the North Island.

Carriage of ore at ordinary shipping rates would be very costly and the steel company would almost certainly require to operate its own vessels to take ore from the North Island

to a South Island site. It is not possible to estimate the cost of this service accurately without relating to specific locations, but it would appear that the extra cost of transport to a South Island site could well be at least £1 per ton carried, which equals £2 2s 0d. per ton of steel product. I must emphasize that these figures are only approximations, but they are certainly of the right order of cost.

PACIFIC STEEL'S MERCHANT BAR MILL

The steel mill which is now being erected near Otahuhu by Pacific Steel Limited is the first step in the establishment of an indigenous iron and steel industry in New Zealand and is thus worthy of closer examination. The mill is situated on a site of some 53 acres in Favona Road in Manukau County adjacent to the N.Z. Railways Workshops and close to the Challenge Phosphate Fertiliser Works. The plan in Figure 5.2 shows the site and the layout of the works on it.

The works is divided into two sections: the melt shop where scrap is melted, the chemical composition of the molten metal adjusted and the melt cast into steel ingots in cast iron moulds, and the rolling mill where the ingots are reheated and converted by a series of hot rolling operations into what are known as merchant bar products (rounds, flats, squares and light angles). Scrap will be received from all over New Zealand and will arrive in the works partly by rail and partly by road. It will be sorted and cut into suitable lengths ready to charge the melting furnace via scrap-loading baskets. There are many grades of scrap and a balanced charge is essential so that the composition of the molten charge can be controlled. The bulk of the charge will be No. 1 and No. 2 heavy melting scrap consisting of steel thicker than one-eighth inch. There will also be sheet steel scrap, baled and loose, steel turnings and some cast iron. Lead must be rigorously excluded as it attacks the furnace lining and the amount of such metals as tin, zinc, and chromium must be minimal and closely controlled.

The melting furnace will be a 40-ton electric arc furnace. It will be quite a large furnace by world standards, although rather dwarfed by the latest mammoth 110-ton furnaces now being installed in some British works. It will have a power rating of 12,500 KVA and will be fed via its own transformer with power at 22,000 volts. It will be capable of producing 40 tons of molten metal every four hours. As scrap is essentially steel, there are few impurities to be removed and therefore only small amounts of slag will be produced. The charge is poured into a large ladle and carried by overhead crane to the casting bay where the molten steel is poured into ingot

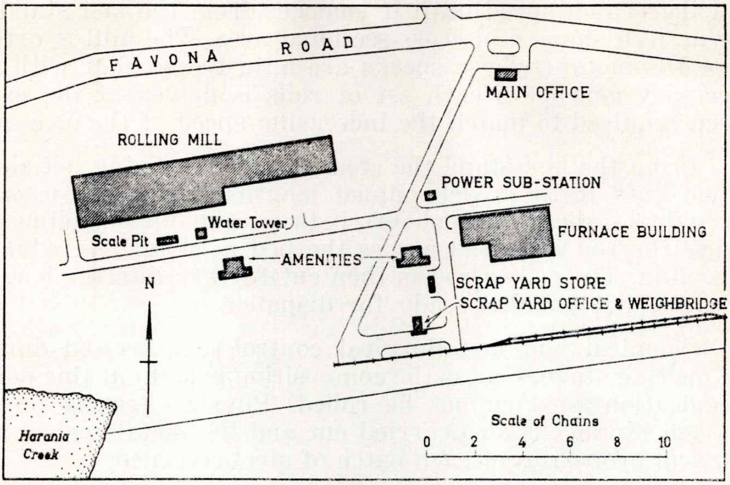

Fig. 5.2. Site Layout of Pacific Steel's Mill.

moulds. On cooling, the moulds are stripped from the ingots and the latter are stored in a yard adjacent to the rolling mill until required for rolling.

The rolling mill consists of four sections—reheat furnace, breaking-down mill, bar mill, and finishing section. The reheat furnace is an oil-fired furnace whose function is to heat the steel ingots to the required rolling temperature. Cold ingots are fed intermittently and hot ingots are correspondingly discharged after passing along the furnace. The hot ingot passes to the breaking-down mill which is a rolling mill consisting of one stand containing three rolls, the top and bottom rotating in the same direction and the middle roll in the opposite direction. The ingot passes through the gap between the bottom and middle roll being thereby reduced in cross section and increased in length. It is then passed back between the top and middle roll and again reduced. Sufficient passes are made to reduce the cross section to a previously determined figure when the piece of elongated steel, which is now called a billet, passes to a second holding furnace where the temperature lost during the breaking down is restored.

Billets are drawn from the holding furnace one at a time and pass to the bar mill. This consists of seven "roughing" stands which are seven sets of rolls in tandem and four "finishing" stands which are arranged in two pairs across the building. In contrast with the breaking down mill, the billet makes only one pass through each pair of rolls and therefore moves continuously in one direction with reducing cross section

and increasing speed until it emerges from the last stand at the desired shape and cross-sectional area. The mill is driven by 4 DC motors whose speeds are adjusted so that with the necessary gearboxes each set of rolls is driven at the exact speed required to match the increasing speed of the steel rod.

From the last stand the steel passes to a flying hot shear which cuts it to predetermined lengths during its passage through the shear and delivers it to a mechanical cooling bed where the rod is moved across the bed mechanically while it is cooling. The cooled rod is then cut further into the lengths required and bundled ready for dispatch.

Chemical and metallurgical control is exercised during the melting stage. Unless the composition is right at this point, specification steel cannot be rolled. Physical testing of the finished product is also carried out and the metallurgical and physical properties of each batch of steel recorded.

The mill will be a big power user, consuming some 50,000,000 kWh per annum and thus in the same class as the New Zealand Forest Products Pinex mill at Penrose. The mill will use large quantities of water both for cooling in the arc furnace and its transformer and for cooling the rolls in the rolling mill. A water recirculation unit will be installed and the bulk of the water recirculated. However, it is estimated that the make-up water required will be over 100,000 gallons per day. The initial staff and labour requirements for the mill are expected to be approximately 250 men and the mill is likely to be in operation by early 1962.

Finally, in order that the site may look as attractive as possible, no manufacturing buildings will be built in a wide strip along its northern and eastern boundaries and these areas will be laid out as attractively as possible in line with modern concepts of landscaping.

ALUMINIUM SMELTING: A POSSIBLE INDUSTRY FOR NEW ZEALAND

Gordon J. Williams, Ph.D., B.E.*

The negotiations which lead to the inception of a new industry are confidential, for not only does premature publicity mislead the public, but it also embarrasses the negotiators. Consequently in this paper I have been careful to use only information that has already been made public in some way or another, even if only obscurely: my premises may therefore not be entirely consistent with the proposals that are under actual consideration.

OUR UNIQUE ADVANTAGES

All countries with fiordlands have a special industrial advantage in that cheap hydro-electricity can be made available and the sources of power are usually also close to deep anchorages for shipping. In this way the fiords of Norway, Scotland, and British Columbia have been widely exploited for the establishment of those industries which are peculiarly dependent upon electric power — the electro-chemical and electro-metallurgical industries. In all cases, though particularly in Norway, the raw materials which form the basis of the industries are imported, and the bulk of the product is exported. In other words the juxtaposition of natural shipping facilities and cheap power has determined not only the site of the industries but even the country in which they are sited. To put it another way, so great is the content of electricity in the processes involved, that the cost of long ocean hauls for both raw materials and the products can be outbalanced by the saving effected by using electricity where it is cheapest.

The two great fiordlands in the Southern Hemisphere have not yet been so exploited — I refer to New Zealand and Chile. They are both remote from the main world markets. I have no information as to what the Chileans may be plan-

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ning, but in New Zealand until now there has been little encouragement for overseas interests, firstly because the development of hydro-electricity has been firmly held as a government monopoly, and secondly because such considerations as taxation or the repatriation of capital seem to have been unfavourable. The insular attitudes seem now to be breaking down. There is arising a general feeling in New Zealand that we cannot continue to be just a farming country; we must have industries also, so that the next generation can find satisfying employment. Our present government has indicated that certain hydro-electric sites may be released for private development, and political attitudes towards taxation and repatriation of capital are becoming more favourable. In this changing political and fiscal climate, therefore, we are now beginning to think seriously of the unique opportunities of our Fiordland as a source of cheap electricity for those industries that need a lot of it cheaply. Fortuitously, remarkable mineral discoveries have been made in northern Australia the utilization of which may need our power: I refer to the huge deposits of aluminium ore (bauxite) discovered in the last few years around the Gulf of Carpentaria.

We are well aware in New Zealand, of the doubts and hesitations that enter into such a potential electro-metallurgical industry as iron and steel; doubts in the economic field as to the costs of the relatively new electric processes for smelting, as to the size of our local market for the limited range of products that could be contemplated, and as to the availability of cheaper steel from Australia or from the expanding steel industry of India in unequal competition with a local industry. These doubts are deepened when we wonder why private enterprise has not already come to New Zealand to work our ironsands, the existence of which has been known for a century, and which are much closer to the blast furnaces of Australia than are Australia's own ores.

But when we think of a possible aluminium smelting industry, we need have none of these hesitations. The raw material has only just been found, and so has not been lying fallow pending the development of a newer and cheaper process, or a rise in population to render it economic. Furthermore, the initiative for such an industry, even though it is as yet only in tentative form, has come from private enterprise itself. There can be no better test of the economics of a contemplated industry than that of noting that private investors are considering spending their own money on it!

So there has suddenly come within our possible reach, a brand new industry far bigger than any other that could possibly come to New Zealand. Whether it really will come

or not, I do not know, but we should keep our fingers crossed! To those of us who live away down south it is a matter of particular importance, for there can be no argument as to its location; it could only come to the southern end of New Zealand, because the only hydro-electric site capable of producing the required power at a satisfactory cost is Manapouri-Doubtful Sound. There is no scope for competitive clamouring among public bodies over the location of this industry.*

THE RAW MATERIAL

Exceptionally, the weathering of crystalline and other rocks results in an economic concentration of lesser constituents. For instance in New Caledonia, the clays derived from ultrabasic rocks which carry a little cobalt and nickel, tend to retain those metals, rather than reject them, to such an extent as to form rich deposits. But here we are dealing with the commonest constituent of clays — alumina. The most abundant constituent of most unweathered rocks is silica, but weathering tends to reduce this constituent relative to alumina. Under suitable conditions, iron is also relatively increased, resulting in "laterite" which blankets so much country in the tropics, but, red as it may appear to the eye, it is not generally rich enough to be iron ore. Concomitantly with the increase in aluminia (and often iron) the alkalis disappear. Thus it is not an alumina enrichment that takes place, but rather the removal of other constituents so that in the half of the material of the parent rock that is left, alumina predominates.

Under ordinary weathering of rocks, as we see it going on in our road cuttings, the process never goes far enough to produce aluminium ore. Only in tropical climates, and where there are pronounced dry and wet seasons, and only in terrains where erosion is slow (as for instance peneplain surfaces) so that the same material remains under weathering influences for long periods, does leaching of the parent rock proceed to such an extent that it leaves an aluminium-rich clay known by the rather indefinite term of "bauxite". It seems to matter little what the parent rock is because most rocks contain a good deal of aluminium. Bauxite deposits are derived from the weathering of rock as varied as basalt, syenite, shale, or schist, and bauxite of even grade may be found over a parent basement of a most varied character.

Certainly bauxite deposits are known outside the tropics, but these are fossil deposits, formed in past times when

* Since this paper was written Australian Consolidated Zinc Pty. Ltd., has announced that it will build an aluminium smelter in Southland. The industry will represent a capital investment of £160,000,000 and will employ 6,000 workers. (Editorial Note.)

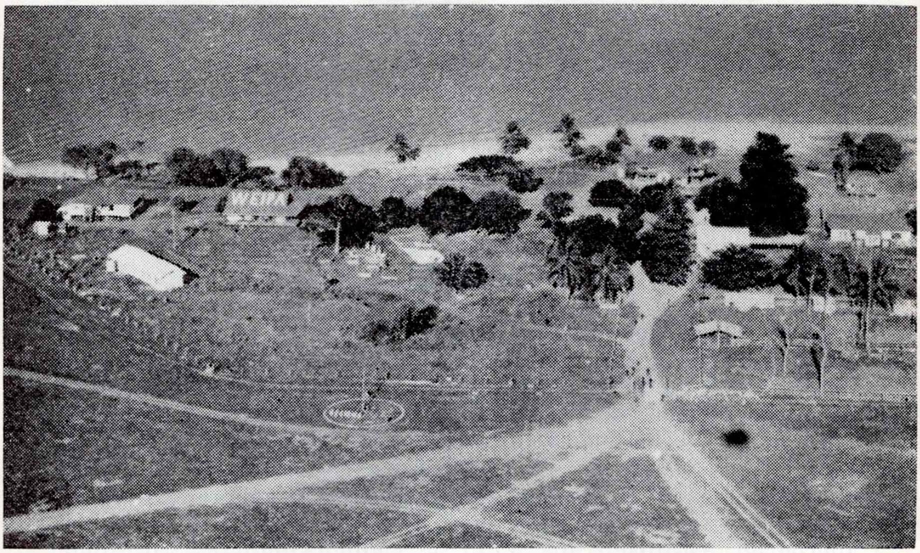

Plate V. The existing Presbyterian Mission on the Embley River at Weipa.

warmer climates crept half way to the poles. Consequently our own bauxites are in Northland, European bauxites are all in Southern Europe, and Russia, with its great need for this modern metal, can seek raw materials only in southern satellites. This is a risk that has driven Russia to develop a unique aluminium industry using alumina-rich rocks rather than clays.

Fossil bauxites are of some economic importance in Europe where the market is close, but generally the most important bauxite deposits are those formed fairly recently (particularly in the warm Pliocene pre-glacial climates) and without other sediments deposited over them, for they can then be opencast with little or no overburden. In such a category fall the bauxites of the Guianas, Jamaica, West Africa, Bintan (an Indonesian island 90 miles southeast of Singapore), northern Australia, and our Northland. Whilst clay materials containing over about 35 per cent of alumina may be called bauxite (some people would extend the use of this indefinite term lower than others), the material is not generally regarded as commercial unless the alumina content is 50 per cent. The upper range is about 60 per cent alumina.

It will be appreciated that the slow, deep-weathering processes that lead to the formation of bauxite from all sorts of rocks, do not entirely eliminate certain impurities.[1]. Some

1. A typical Queensland analysis is: Al_2O_3, 57.2%; Total SiO_2, 5.7%; Quartz, 1.8%; TiO_2, 2.5%; Fe_2O_3, 8%; Loss on ignition, 26.5%.

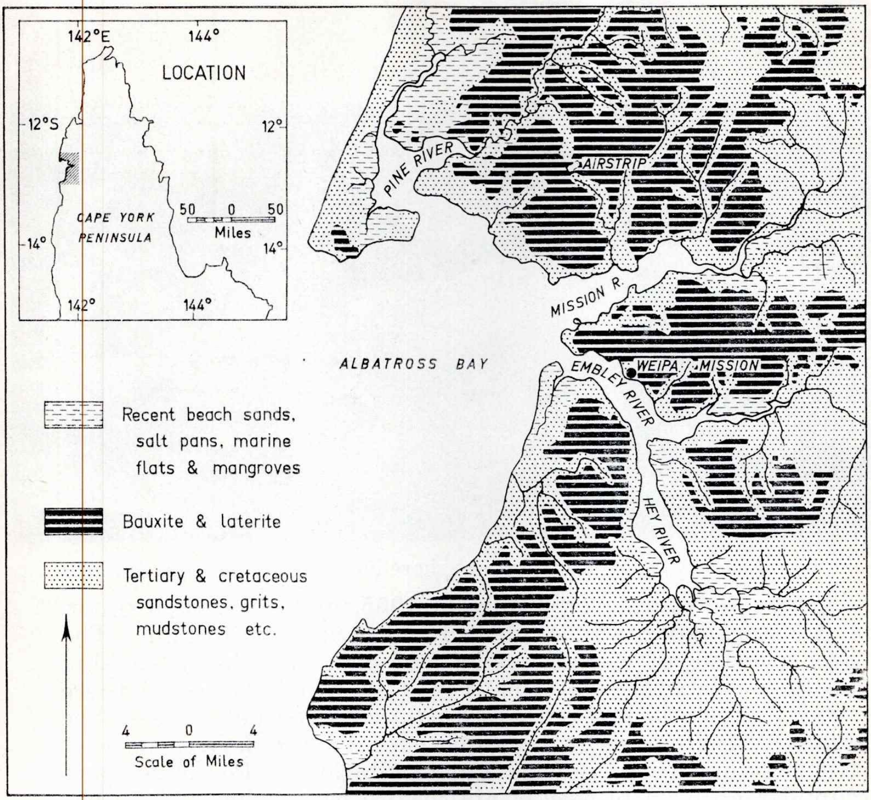

Fig. 6.1. Location of bauxite deposits on Gulf of Carpentaria.

of these do not matter, but others do, because they interfere with the process in which alumina is extracted from bauxite. Of these impurities, iron is irrelevant so long as it is in the ferric condition; ferrous iron uses up the soda solution used in processing. Titanium does not matter if the process is designed to treat the trihydrate ore, but with processes which are designed for the monohydrate ore, titanium tends to consume the alkali. Phosphorus is undesirable for it is carried through to the metal on which it has a detrimental effect. Silica is the impurity most to be avoided. So long as it is free silica (as in sand grains) it is not so difficult, but the silica which forms part of the clay minerals is reactive and dissolves in the caustic solutions and so uses up a lot of the soda.

The main area of the deposits in Australia is in the region of the isolated mission station at Weipa on the eastern shores of the Gulf of Carpentaria. (See Plate VI.) The

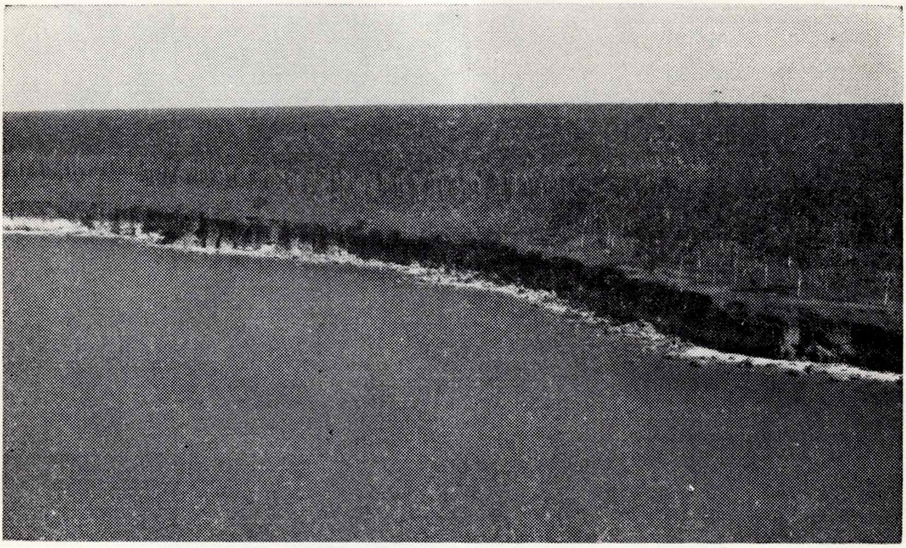

Plate VI. Bauxite outcropping on shoreline of Gulf of Carpentaria.

deposits were discovered only in 1955, and since then other, but lesser, deposits in Arnhem Land have come to light. The area consists of coastal plains and mangrove belts, backing on to low lateritic plateaus (Fig. 6.1) which here and there reach the sea in low red and cream coloured cliff faces. (See Plate VI.) Weipa is inaccessible except by a dry-season cart track from York Downs Cattle Station. Personnel and supplies go by a bi-weekly air service established via Cairns and Horn Island, and heavy supplies are taken by shallow draft coastal vessels. The tree-spacing on the lateritic plateaus is wide enough to enable vehicles to move about.

The parent rocks consist of gently warped Mesozoic and Tertiary sandstones, grits, mudstones, etc. The bauxite is a mixture of the tri-hydrate (gibbsite, $Al_2O_3.3H_2O$) and the monohydrate boehmite ($Al_2O_3.H_2O$) varying in thickness up to 30 feet. The material is nodular or pisolitic, and grades down without a marked break into the underlying sediments. The monohydrate, which ranges up to 40 per cent, tends to decrease with depth, the richest being within 6 feet of the surface, and it is believed to be due to secondary weathering of the bauxite material above the zone representing seasonal fluctuations at the top of the water table.

There are 500 square miles of laterite, and 200 square miles of this can be classified as commercial bauxite. The tonnage ultimately proved by drilling may exceed 3,000 million: perhaps a quarter of the known world reserves. The

deposits are proved by scattered scout drilling at centres 4,000 feet apart to give a broad picture of grade and thickness, and then by closely spaced drilling at centres 1,000 feet apart and even closer in areas where high grade material is revealed in the scout drilling. The drilling is done with post-hole or spiral diggers, so as not to break the pisolites, which, if brought up whole can be screened from sand lying between them. (See Plate VII.)

PROCESSING

Conventionally, the means of converting bauxite into aluminium metal involves two separate processing stages. Firstly there is the production of alumina from bauxite, and secondly the production of the aluminium metal from alumina. These two stages in the process have very different requirements, the former being a thermal process needing a lot of heat from coal, and the latter a lot of intense heat from electric power. Let us follow these two processes briefly, and note particularly the requirements in power and raw materials, and the costs involved. We might base our figures on the production of 1 ton of aluminium metal. This is derived from 2 tons of alumina, and in turn, from about 4 tons of natural bauxite.

The bauxite to alumina stage is usually accomplished by what is known as the Bayer Process. The bauxite is crushed and then heated to evaporate the uncombined water, and to oxidize any ferrous material present. It is then again crushed, and mixed with sodium hydroxide solution in steam-heated autoclaves to produce sodium aluminate; the resulting liquid is then pumped into settling tanks, and the sodium aluminate decomposes to release alumina, which is calcined to produce the dry oxide.

Two tons of alumina (which will later become 1 ton of aluminium) require: 4 tons of bauxite, 240 lb of soda, 12,800 gallons of water, 54 kWh of power, 11.4 man/hours of labour, and 1.2 tons of high rank coal or 4.4 tons of lignite. It will be noted that power requirements at this stage are mostly derived from coal, with a negligible contribution by electricity.

Aluminium requires a greater amount of heat to reduce it from its oxide than does almost any other common metal. This heat can be obtained only by electricity, and in the electric furnaces where alumina is converted to aluminium, 20,000 kWh are used per ton of aluminium produced. This electricity is provided through carbon electrodes, of which 1,600 lb are used per ton of metal produced. The electrodes are made of petroleum cake, from coal, or from a mixture of both. The manufacture of these electrodes is a skilled procedure, and the raw materials are subject to strict impurity

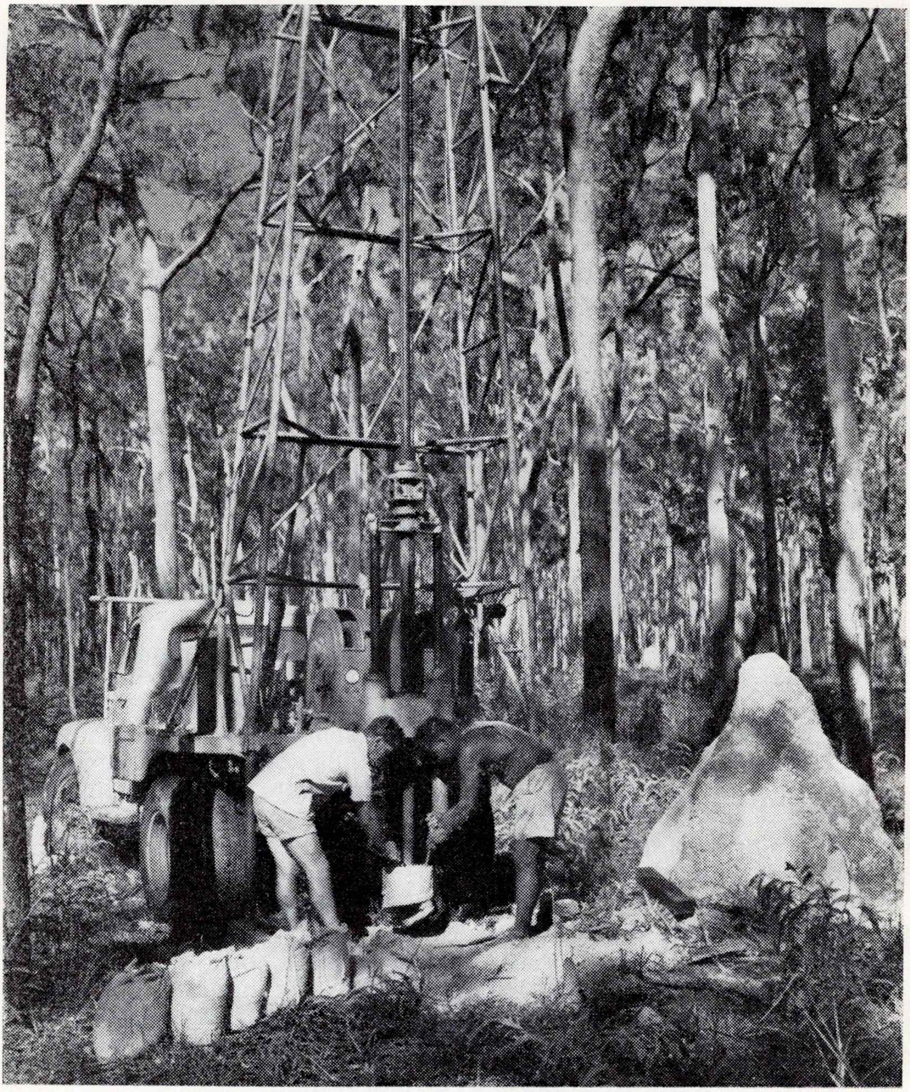

Plate VII. Sample drilling in one section of the bauxite deposits at Weipa. The mound at right is a termite nest built predominantly of bauxite.

tolerances: for instance neither ash nor sulphur may exceed 0.75 per cent, thus demanding the use of especially selected coals. Nevertheless, with such large quantities of electrode used, we should look to the possibility of establishing a subsidiary industry (perhaps on the West Coast) if aluminium smelting should come to New Zealand. It would be a good

gamble to start research without delay, to find out if we have suitable materials, and if we can process them satisfactorily. The electrolyte is the mineral cryolite (AlF_3 3NaF') with some fluorspar (CaF_2), the consumption of which is of the order of 7 per cent of the weight of metal produced. These would have to be imported into New Zealand unless we can discover local sources. There is some fluorite in Nelson.

If we regard the annual production of 250,000 tons of aluminium metal as a possible target, from the figures given above we may deduce the annual figures given Table 6.1.

TABLE 6.1

REQUIREMENTS BAUXITE-TO-ALUMINA STAGE	
Bauxite	1,000,000 tons
Alumina produced	500,000 tons
Soda (imported)	3,000 tons
Electric power	13,500,000 kWh
Coal (high rank) ,or	300,000 tons
Lignite	1,100,000 tons
Labour force (say)	3,000
Water	6,000,000,000 gals
Capital requirements:	£(Stg)40,000,000
REQUIREMENTS ALUMINA-TO-ALUMINIUM STAGE	
Alumina	500,000 tons
Electric power	5,000,000,000 kWh
Coal for electrodes	200,000 tons
Cryolite and fluorspar	17,500 tons
Labour force (say)	6,000
Annual Value of product	£60,000,000
Annual Value Added in New Zealand (say)	£40,000,000
Capital requirements:	£(Stg)125,000,000

The figures for capital requirements are average ones, varying according to the size of plant contemplated, the cost of materials and labour, the need or otherwise for the establishment of community services, etc.

Vast as these figures may seem to us in New Zealand[2] they are based on an assumed rate of production (250,000 tons of metal annually) which is modest alongside the increased production that will be necessary to fulfil world demands, and also in relation to the fact that Queensland has at least a quarter of the known world reserves of raw material.

WORLD PROSPECTS FOR ALUMINIUM

With the exception of iron, aluminium now outstrips all other metals in terms of tonnage produced. From a world production of 43,800 tons in 1910, aluminium is now pro-

2. Particularly in relation to other projects: for instance, an indigenous iron and steel industry might initially need no more than £20,000,000; a carbide industry less than £2,000.000; and the still rather nebulous oil shale development perhaps £25,000,000.

duced at a rate of 3,250,000 tons a year (and being so light, 3,250,000 tons go a long way). The production is accelerating rapidly, because no significant markets have recently been lost to competitive materials, whilst the uses of aluminium are being extended by research.

The Americans are well ahead of the world in their appreciation of the uses of this metal. A reliable authority has estimated that the use of aluminium in the average American house will increase from 30lb today to 1,000lb in 1965. Used structurally in building its lightness decreases the dead-weight as much as 60 per cent, so that less expensive foundations are needed, and maintenance costs are very low owing to corrosion resistance. Aluminium is worth about £197 per ton as compared with £33 for steel, but this difference may be offset for certain purposes by the advantages just mentioned. It is interesting to note that 100 years ago, aluminium was a rare metal commercially. It was then worth £60 per pound whereas it is now worth 2 shillings per pound!

The use of aluminium foil in packaging is extending rapidly; motor cars contain from 35 to 78 lb each; its use for irrigation piping is extending; new aluminium alloys mark the break-through of the thermal barrier in supersonic aircraft. I need hardly mention the wide use of aluminium in electric transmission; the recent collapse in copper prices is in some measure due to the displacement of copper by aluminium in the electrical industry.

I have already referred to a production of 250,000 tons of aluminium metal per year as, perhaps, the sort of objective that is being considered for New Zealand smelting, and also that the newly discovered Australian deposits represent about a quarter of the known world reserves — 3,000,000,000 tons as against a total of over 10,000,000,000 tons. But we cannot immediately deduce from this that Australia will find it possible to produce a quarter of the world's requirements of aluminium. We must balance against this accidental location of bauxite, the geographical situation of aluminium markets, the anticipated requirements of aluminium on world markets, and the capacity of existing plants to meet these requirements before there is an incentive to open new plants. At the moment, aluminium plant capacity exceeds the demand, but the demand is growing so very rapidly that new aluminium plants must be opened up somewhere before long. Can Australian bauxite contribute to this?

Let us look briefly into the statistics of the industry. The existing world consumption is of the order of 3,250,000 tons, of which about 5 per cent is contributed from scrap, and the remainder from virgin smelting operations. But,

unlike steel and the base metals, the markets of which depend upon a natural growth of long-standing usages (losing ground in some cases to new materials), aluminium is vigorously pushing its way into new fields, and in the coming years its annual increment of growth may be expected to transcend that of the older basic metal commodities. On average, during the last decade, consumption has increased by 200,000 tons per year (or by 190,000 tons of primary metal). The industrial distribution of developments leading to these increases from 1950 to 1958 is evident from the percentage increases in consumption given in Table 6.2. The United States shows up relatively unfavourably because of its advanced initial stage of development.

TABLE 6.2

PERCENTAGE INCREASE IN ALUMINIUM CONSUMPTION

1950-1958

	U.S.A.	8 other countries[3]
	%	%
Building products	76	42
Transportation	77	129
Electrical industries	34	260
Household goods	9	50
Packaging	100	155

Predicted demands, as given by one authority, are shown in Figure 6.2 from which it is evident that by 1975, we may expect consumption to rise to something like 8,000,000 tons. A beginning must be made in about five years time to increase existing plant capacity or build new plants to the total extent of 3,200,000 annual tons by 1975. (It will be noted that my assumed output of 250,000 tons for New Zealand is only one-seventh of this.) World reserves of bauxite, as we have noted, are 10,000,000,000 tons, representing perhaps 2,500,000,000 tons of aluminium, sufficient for world needs at the increasing rate anticipated for at least a century.

It is pertinent to note that the existing capacity on the Pacific Coast of North America is 800,000 tons, and is capable of being increased, particularly at Kitimat. Plans are already in hand for new plants in Argentina, Venezuela, and Peru in South America, and in France, Spain, Yugoslavia, and Norway in Europe. In Asia, potentialities of raw materials and power exist in China, Japan, India and perhaps Sumatra, whilst in Africa there are combined potentialities of power and raw material (in some cases carried to the extent of specific plans) in Ghana, the Congo, French Guinea, and French Equatorial Africa. The United Nations is known to be interested in some of the plans. Furthermore another

3. United Kingdom, France, West Germany, Italy, Japan, Canada, Norway and India.

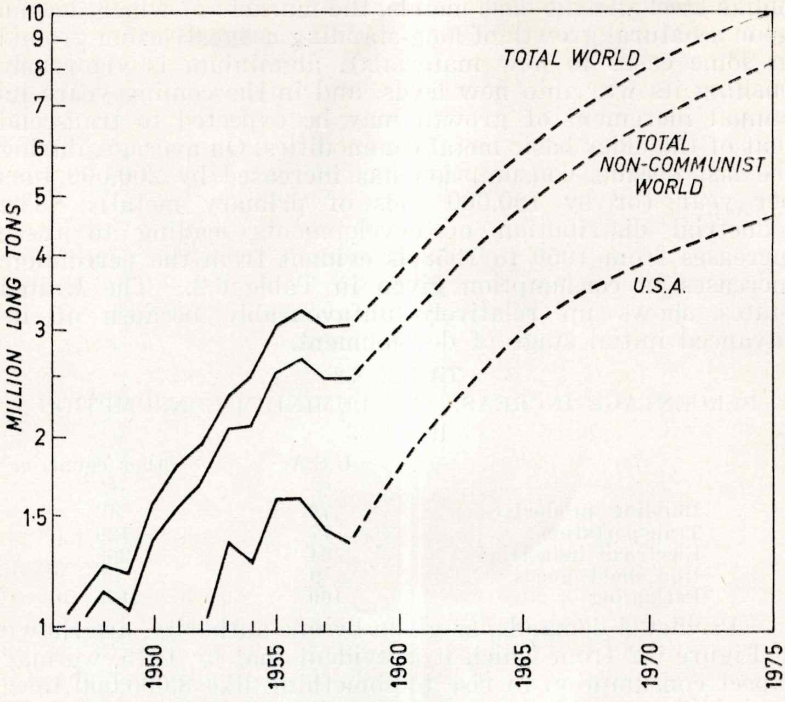

Fig. 6.2. Projected growth of aluminium demand.

factor is appearing on the horizon; that of deriving aluminium from other aluminous raw materials, such as nepheline or sillimanite (the latter already being used in Russia as we have noted) and recent work on extraction from aluminous clays is showing some hint of economic possibilities.

On balance, it may be conservatively conjectured that there is no very great hope of aluminium derived from Australian bauxite entering competitively on world markets for a decade. Competitive ability may hinge considerably upon African developments, and on political conditions there.

POWER

We have noted that the production of 1 ton of aluminium requires 20,000 kWh, so that the cost of electric power must be regarded as the dominating factor. It is simple arithmetic to find that every 0.1d. per kWh in the cost of power represents £8 a ton in the final cost of the metal. It is for this reason that smelting is done in countries where cheap hydroelectric power is available. Power costs in large established

plants are quoted as being as low as 0.1d. or 0.2d. per kWh in Canada and for African projects. Some European costs as high as 0.4d. are compensated by nearness to markets, cheapness of reagents, etc., and in some countries national pride may increasingly be expected to press for local schemes which are not entirely economic in a world sense.

What alternatives have the Australian interests to Manapouri? We know they are considering the Purari River in Papua, which is geographically close and is in Australian territory. But, although this river may have a sufficient potential (say 750,000 kW), capital costs are bound to be high in such tropical terrain; there would be a high capital expenditure on the establishment of harbour facilities and social amenities and services, and I understand it is not a very easy site. I have heard it stated that this might add up to over £200 per kW in capital cost.

I believe that deep drill holes have already been sunk in the Weipa area on the chance of finding oil or natural gas, without success. The Queensland Blair Athol coal might also be considered. I wonder if the reserves are sufficient not only for an alumina plant, but also for electric generation on a large scale for the production of aluminium metal? Certainly, anyway, coal-firing could not give costs of the order of 0.2d., particularly as a long transmission line to the coast would be needed. Further, atomic power at the site could be considered. Although atomic generation costs are likely to fall, they are as yet of the order of 0.5d. in Britain, and would be higher for an isolated plant in Australia, with all the problems of waste disposal, the reservicing of rods, and other difficulties peculiar to the use of atomic energy.

We in New Zealand must therefore be in a position to offer a natural situation where power costs are so low that the freight on the alumina (say 500,000 tons a year on our assumed scale) from Queensland, and the freight on the bulk of the metal to world markets can be absorbed. Apart from these factors Manapouri undoubtedly represents the cheapest power available in Australasia, and is the only single site where something like 1,000,000 kW can be produced on a 50 per cent load factor (or say 600,000 kW on continuous load).

I know of no published estimates of the cost of power from the Manapouri-Doubtful Sound site, or of the capital costs. But we may be guided by figures for Benmore, where for a plant of 480,000 kW capacity, costs are expected to be 0.29d. per kWh and £75 per kW respectively. The southern site provides a larger capacity, and possibly a less costly one per kW, so that we may expect to improve considerably on Benmore figures, (particularly so, as we would be concerned with a continuous load). To these of course would have to be added

the cost of a 100-mile transmission line to Bluff. At least we can confidently guess that we have much more advantageous figures than those for the Purari, but they must be sufficiently more so to offset the longer ocean haul.

WHAT ARE OUR CHANCES?

There can be nowhere in the world except Southland where the bauxite-to-alumina process and the alumina-to-aluminium process might be undertaken at one site. In other words, where both cheap hydro-electricity for the metal process and cheap coal for the alumina process are side by side; and where there are already established deep-water harbour facilities, abundant flat land, and a harbour town and provincial city with their existing services. The site is only 100 miles from Manapouri, and the Mataura valley lignites extend towards Bluff, probably closer than we yet know.

But there are always two sides to a story, and against these striking advantages certain inescapable doubts have to be offset. We have seen that plant capacities already exceed demand on a world basis and that the outlook for a new plant is not immediately good, though reasonable on a long-range basis. There are also other difficulties. Firstly, it can hardly be expected that the Commonwealth Government (which controls mineral privileges in the Northern Territory), the Queensland Government (which does likewise in Queensland), and the Tasmanian Government (which jointly with the Commonwealth operates the Bell Bay aluminium plant in Tasmania) would view with complacency the excavation of wide areas of bauxite merely for export*. Rather it might be expected that the privileges would be granted under conditions that demand that at least some aspects of the treatment are undertaken in Australian territory. In fact, this is the case. The Commonwealth Aluminium Corporation Pty. Ltd., with which the British Aluminium Co. Ltd. is associated, has negotiated a long-term agreement with the Queensland Government, covering the known and expected bauxite areas of commercial grade. Inter alia, this agreement provides that the Corporation will establish an alumina plant in Queensland as soon as practicable. Furthermore the Arnhem Land deposits have been acquired by the same organization, which has also taken an option over the Blair Athol coalfield, believed to contain 200,000,000 tons capable of being worked by opencast methods. Concurrently, steps have been taken to investigate the hydro-electric potentialities of Papua and New Guinea, with a view to the establishment

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* Since this paper was written the Bell Bay plant has been taken over by Consolidated Zinc Corporation Ltd. (Editorial note.)

of a smelting plant to treat the alumina produced in Queensland. Tentative investigations have been made of the Manapouri-Doubtful Sound hydro-electric potential and certain preliminary negotiations appear to have been entered into with the New Zealand Government.

Much of the world bauxite production is shipped to aluminium smelting countries—from the Caribbean to North America, from West Africa to Europe and Canada, and on a lesser scale from Indonesia to Japan, Europe and Australia.

We have noted that alumina represents only half the original bauxite. (See also the analysis, footnote 1, page 92.) Consequently there is a growing tendency to ship alumina rather than bauxite from the sites of the natural occurrences; the former is worth £30 per ton as against perhaps only £2 per ton for the natural material. There is perhaps some hope for an export market from Australia in alumina—at least a more immediate hope than for aluminium. This being the case, and because of the conditions of Australian leases, and because probable needs for alumina and aluminium on world markets are not synchronized as to time, it seems unlikely that an alumina plant will be established in Southland.

Further, as an interim measure, it is possible that aluminium smelting capacity will be increased in Tasmania where the Bell Bay plant, with a capacity of 13,000 tons, is well behind the national consumption of 30,000 tons*. This will need more than merely an increase in the capacity of Bell Bay, for this plant is equipped only for treating the trihydrate ore from Bintan, and not for monohydrate ore.

Clearly, then, if New Zealand is to come into the picture it may do so only on the basis of the smelting operation and only on a long-range basis, perhaps a decade hence. As it would clearly take several years to construct such a huge plant, we need not be too despondent of seeing some action before too long.

NEW ZEALAND'S POTENTIAL GAIN FROM THE INDUSTRY

Our recent industrial developments (e.g. timber and paper) have been financed only by straining our financial resources and calling upon government help. Aluminium is in quite a different category. We have the natural advantages, and private enterprise from abroad is looking into the possibilities of using these advantages with their own money. In the general plans for the domestic development of hydro-

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* Since this paper was written, plans for increasing the capacity of the Bell Bay plant have been announced in the press. (Editorial note.)

electricity in New Zealand, Manapouri ranks low because it is remote from the parts of New Zealand where our power needs are greatest. Conceivably the time is so remote before we need this power for general purposes that atomic power may beat it in costs. I therefore feel we are on safe grounds to allow this power asset to be developed and used for exclusively industrial purposes.

Many people have suggested to me that if we bring raw material to New Zealand and then export almost all of it again—what do we gain? Surely the establishment of an industry costing £125,000,000 in the south of New Zealand where industries are most needed to balance geographically our industrial economy, could not but have a beneficial effect in itself. An additional labour force of 6,000 in the Invercargill region has not only to be multiplied by the size of their families but also by those who service them in so many directions.

Furthermore, many ancilliary industries would inevitably develop. I have already mentioned the possibility of producing the electrodes, an industry that would increase our coal consumption by one-twelfth. The raw materials would probably come from the West Coast where new industries are so much needed.

Aluminium fabrication, and particularly the latter part of it—the fashioning of aluminium forms—lends itself to relatively small-scale production. We live in a highly educated country in which, in consequence, there tends to be more skill than opportunity to use skill. Surely an aluminium project, from which we could locally receive aluminium ingots at world prices, rather than at world prices plus freight, would give us an opportunity to use these skills. Our technical colleges on the one hand, and the technological parts of our universities on the other would, I am sure, not be slow to exploit the position by devising training leading in this direction.

We hear a lot about the loss of trained technologists. An educated community such as ours in New Zealand must produce such people because our economy is so much oriented towards farming, so that those with other inclinations tend to leave to gain satisfying employment. We therefore need industries, not only as an incentive to the small proportion of our population who desire a medium of expression for their technical or technological skills, but also to balance a narrow economy by the development of industry other than one based on our soils.

We have some minerals—more than is realized by the general public—but our greatest immediate asset is our

hydro-electricity. With other forms of power development looming, we may miss out even on this asset unless we grasp it soon. We have less than a decade in which to decide. Why should the export of electric power, in the form of metals processed by it, be regarded differently from the export of other forms of primary produce even if the raw materials come in to us, and mostly go out again? We must still gain a lot economically in this process.

On the contrary there are many who do not want the industry because they envisage the spoiling of our scenery, and of our fauna and flora. I cherish these natural assets very deeply personally and I do know the Australians are as keen as anyone of us to preserve these natural heritages. The design of the scheme and the extent to which it would intrude on the natural landscape is a civil and electrical engineering matter which I am not competent to discuss. I only attempt to present to New Zealanders the biggest scheme that could possibly come to us. We must decide whether the coming generations are to derive the economic advantages from this or whether we prefer them to live in an underpopulated country with an unbalanced economy. In this paper I present the side which is little known to the public.

NEW ZEALAND BAUXITE

At the Fourth Triennial Mineral Conference held at the Otago School of Mines last September, Dr. Swindale of the Soil Bureau revealed the discovery of bauxite in Northland, near Kerikeri. It is therefore proper that this discovery should be considered within the context of this paper. Although we as yet know little about our bauxites, we do know enough to be able to say that they present an entirely different set of technological and economic problems than do the Australian bauxites.

The bauxite occurs on old basalt surfaces, to the extent, it seems, of about 5 square miles, though one would rather expect that other areas may also be discovered. Nevertheless the scale of occurrence is very much less than that in Australia though this is not necessarily a disadvantage for, as we have seen, there is more than is likely to be needed in Australia.

If a typical analysis[4] is compared with that of the Weipa bauxite (page 92), it will be seen that alumina is lower and iron is higher in our ore. This would render the Bayer Process for the production of alumina uneconomic, but as Dr. Swindale has suggested, another process, already in commercial

4. Extractable Al_2O_3, 38.6%; SiO_2 1.9%; Fe_2O_3, 21.3%; TiO_2, 2.6%; loss on ignition, 28.2%.

production in Norway, might be used. This is the Pedersen Process, in which the ore is smelted in an electric furnace with limestone and coke and the slag is leached with sodium carbonate to extract the alumina. Costs are substantially higher than in the Bayer Process, but to offset this, pig iron is a by-product (and ferro-titanium might also be). The alumina, of course, still has to be reduced in an electric furnace.

It will be time enough to look into the economics of this process when we know more about the occurrence, grade, and extent of the bauxite. But we at least know that as electric power is used both in the alumina and aluminium stages, more power is needed per ton than with the conventional processes. On the other hand, neither the likely scale of the ore reserves nor the process lend themselves to the vast scale of operations envisaged for Southland.

Furthermore sea-freight costs from Northland to Southland are as high as from Australia. In consequence, with our own bauxite we can by no means say at this stage that the logistics point inevitably to a plant in Southland, as they must with Australian bauxite.

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THE ROLE OF CONSUMER INDUSTRIES

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New Zealand's central economic fact is vulnerability to external influences which we cannot control. This vulnerability is the result of excessive dependence on a narrow range of exports and on too high a proportion of imports to total production. Put in another way, it is the result of New Zealand's making too little use of resources, including human skills, available in New Zealand and relying too heavily on imports. In addition, New Zealand's recent rate of development has lagged behind that of many countries of the world.

The farm products which earn 95 per cent of New Zealand's export income are luxuries to most of the world's consumers. The few markets where these products are more nearly necessities are either expanding at only a slow rate, or policies of agricultural support and protectionism are restrictive in their effect on New Zealand's exports. (There are exceptions to this, of course, for example, the possible scope for increased lamb exports to North America.)

Conversely, New Zealand's dependence on imports is increasing. From 1951 until 1958 imports as a percentage of goods available for use in New Zealand rose from 42.6 to 46.6 per cent - a proportion far higher than that of most of the countries of the world that can reasonably be compared with New Zealand. The effects of this situation were seen in the late 1950s when fluctuating export receipts, a continuing high demand for imports and falling terms of trade culminated in the balance of payments crisis of 1957 and 1958, and in the near exhaustion of New Zealand's overseas reserves. It was necessary to intensify and extend import licensing and exchange control, to take measures to restrain demand, and to undertake heavy borrowing abroad.

It has become generally accepted that modification of New Zealand's vulnerability lies in the greater diversification of the economy, including expanding the range of exports, increasing the value of exports by further processing, extending existing export markets and opening new ones, and develop-

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* Dr Sutch is Secretary of the Department of Industries and Commerce.

ing to the full the increased production of New Zealand goods and services, particularly to reduce the undue reliance on imported goods. It is with this background that we can discuss the role of New Zealand's consumer industries.

THE EARLY DAYS

One of New Zealand's first industries produced capital goods - ships and ship's parts - and the New Zealand content of these goods was very high. These were for world buyers; for whalers, sealers and others visiting New Zealand. Most of the early industries, however, were consumer industries. They too had a heavy New Zealand content. Those early industries were restricted in growth and range by the fact that the markets were small and local and their customers were people on low incomes. Industry grew from the skills brought by the artisans who came to New Zealand; there was no government help. The various settlements were, moreover, almost isolated from the world and imports were infrequent and expensive. Thus the first industries were based on the specialized skills of such artisans as blacksmiths, coopers, joiners and sawyers who made and repaired the articles demanded by the small communities.

The development of consumer industries in New Zealand since then has continued to be conditioned by the factors I have mentioned; the size of the market, the living standards of the consumer, technical progress and the results of government action. The size of the effective market (that is the market that could be reached at reasonable cost and convenience) and the living standards of the consumer determined whether the demand was large enough to support the minimum economic output required for the production of certain goods. Even this has not been a stable element, however. For example, the steady decline in freight rates on imports as the sailing ship was replaced by the faster and larger steamship may have meant that some industries which could have competed with imports in the 1860s if given sufficient market, could not have competed in the 1890s.

When the living standards of the consumer rose they encouraged the production of not only a greater volume of goods, but a greater range. The early New Zealander walked until he could afford to buy a horse with saddle and harness. As his real income grew he could buy a cart, later a buggy and perhaps a carriage - and he wanted to have a selection to choose from.

Before 1860 the products of factories were simple consumer goods, materials for houses and tools and equipment for farms. These satisfied the basic needs of a population which reached 100,000 in the early 1860s, grouped into separate isolated settlements, and linked with the United Kingdom by irregular sailing ships' voyages of about 110

days. The products of these industries (except the iron and brass foundries and the engineering works) were based almost entirely on New Zealand materials and skill was an important element in the manufacture.

THE GROWTH OF THE MARKET

Despite the fact that a substantial part of the remainder of the nineteenth century in New Zealand was taken up by an economic depression, manufacturing expanded. The population grew from 100,000 in the early 1860s to 625,000 in 1890. The rising demand for imports which were valued at £1,500,000 in 1860 and at £6,300,000 in 1890 shows that, despite economic distress in the meantime, and despite little or no improvement in individual living standards, the market had expanded very substantially so that by 1890 the estimated value of manufacturing output was £8,200,000. Of this about £1,500,000 was in meat-processing mainly for export; some £4,200,000 in the manufacture of consumer goods (mainly food, beverages, apparel and footwear); and approximately £2,500,000 in the production of raw materials and equipment for manufacturing, farming and building.

By this time the market was closer knit by improved internal transport. Over 4,000,000 tons of goods were being moved by coastal shipping in 1890 and by that year almost 2,000 miles of railway was open for traffic or under construction. The urban population was growing. In April 1891, the total population living in and around Auckland was 51,127 (more than the total New Zealand European population had been 24 years before); Christchurch had 47,846 people; Wellington 33,224 and Dunedin 23,489.

The imports of the early 1890s that can be readily identified were mainly consumer goods; textile products, sugar, beverages and tobacco accounted for about one-half of all imports. Raw materials in partly processed form (pig iron, wrought iron, wire), railway plant and equipment, and agricultural and industrial machinery were the other major imports but the identifiable imports in this category accounted for less than one-sixth of the total.

By 1920, when the population had nearly doubled - to 1,200,000 - the value of New Zealand factory production had grown ten times since 1890 - to £82,000,000. Imports in that year had also increased almost ten-fold to £62,000,000 but fell back to between £40,000,000 and £50,000,000 in the remaining years of the decade. Factory production also declined in value after 1920 but by 1930 amounted to over £90,000,000.

Much of the increase in production had of course occurred in the processing of food for export. But the enlarged market and the rise in real incomes also permitted substantial ex-

pansion in such consumer industries as woollen milling and the manufacture of clothing and footwear. The enlarged market was mainly the result of heavy immigration which was resumed after the depression of the latter part of the nineteenth century.

The rise in incomes, which followed the breaking-in of intensively farmed areas and the development of refrigerated exports led to a demand for more expensive goods. This demand was met partly by New Zealand production, but mainly from imports. The greatest increases in manufacturing output over the 30 years from 1890 to 1920 had come in the industries which supplied basic needs - clothing, footwear, furniture - or processed materials for industry (such as tanning and woolscouring) and farm products for export.

PROTECTION

Despite the increase in such consumer manufacture in New Zealand, imports of similiar products were still large and sometimes supplied as much as one-third to one-half of the market - in apparel and footwear for example. But heavier protective tariffs, progressively extended since their introduction as a recognized protective policy in 1888 were now assuring the New Zealand manufacturer of at least a partial share of the domestic market. Most of the duty was on imports of clothing and textiles, and this was where the greater part of the increase in manufacturing had come.

There were, of course, other forms of protection for many New Zealand manufacturers. The sawmills and sash and door factories, the output of which rose almost five times over the 30 years to 1920, were protected by the heavy bulk of their products and the need for the user to be close to the supplier to be sure that his special wants were met. The foundries and other engineering works, brick makers, furniture makers, breweries, aerated water manufacturers and coach builders were similarly protected, as were the producers of perishable goods such as bread.

If we exclude those processing farm products, it was the industries protected by tariff or geography (including shortages in the 1914-18 war) that made the most significant contribution to manufacturing expansion in these 30 years. By this time industry was much more heavily mechanized. The estimated horsepower of all "manufactories and works" in 1896 was 28,000 for 27,389 workers. In 1920, 217,173 horse power served 52,221 workers - an increase from just over one horsepower for each worker in 1896 to four horsepower in 1920.

SUMMARY UP TO 1920

At this point we can summarize what had happened. The population had grown, mainly through immigration, and it had become relatively wealthier, particularly because of

the development of farming for export. High export prices during the 1914-18 war had multiplied the income effect of this new production. There was greater population in the towns, and communications throughout New Zealand were well advanced. These set the stage for an increase in manufacturing, and at the same time for a heavy increase in imports. Where factories were protected by tariff or by "natural" conditions they expanded. The greater part of secondary industry processed New Zealand raw materials (notable exceptions being imported cotton piece-goods and metals). The labour employed was using much more machinery, and less skill was involved than in the days of the cooper and the shipbuilder.

The New Zealand consumer participated in technical advances mainly through imports. "Automobiles, motor cars and motor cycles" to the value of between £2,000,000 and £5,000,000 were imported in the 1920s, although bicycles were being assembled here from imported parts. Many of the imports, for example candles, carpets, cement, earthenware fish, fruits, furniture and leather, were made from materials readily available in New Zealand. Some of them (candles, carpets and leather manufactures) could have been made from materials originally exported from New Zealand.

THE TWENTIES

Table 7.1 shows how between 1920 and 1929, the pattern of manufacturing changed slightly.

The part played by factories processing for export increased over the 1920s, that is other types of manufacturing decreased proportionately. Technical changes are apparent in the more rapid growth of the "heat, light and power" and "carriages and vehicles" industries, and the corresponding relative decline of the "harness, saddlery and leatherware" industry, for example. The fall in the "textile fabrics" and in "apparel" industries' share of total manufacturing output was heavy, and there was also an absolute decline in these industries' output, that is, demand tended to be directed to imports rather than to New Zealand produced consumer goods. If we exclude the year 1920 when import prices were abnormally high the value of imports of apparel and hosiery and boots and shoes increased in the 1920s, apparel and hosiery from £2,500,000 in 1921 to £3,100,000 in 1929; and boots and shoes from £500,000 to £1,000,000 over the same period.

THE THIRTIES

The change in the pattern of manufacturing between 1929-30 and 1938-39 was even less than in the preceding nine years, although metal working and vehicle manufacture improved their position significantly.

With the contraction of export income and the drop in internal purchasing power between 1929-30 and 1931-32 manufacturing output decreased. Consumer goods industries were particularly affected by the decline, and the corresponding fall in competitive imports was of little help to them because of the heavily reduced purchasing power of the consumer. For example, there were 166,008 suits manufactured in New Zealand in 1929-30 and 114,445 in 1931-32, a fall of 30 per cent; and the production of children's boots and shoes fell from 119,888 pairs in 1929-30 to 87,755 in 1932-33, a fall of nearly 27 per cent. The volume of manufacturing output reached the 1929-30 level some five years later. The depression was thus a very heavy setback to manufacturing industry in New Zealand.

TABLE 7.1
VALUE OF FACTORY PRODUCTION IN NEW ZEALAND
(Percentage of Total)

	1920-21	1929-30	1938-39
Animal food	40.5	43.5	43.2
Vegetable food	6.1	7.0	5.6
Drinks, narcotics and stimulants	3.3	3.5	3.7
Animal materials, other	2.3	1.4	2.0
Woodworking	6.8	5.7	5.7
Vegetable produce for fodder	0.1	0.1	0.1
Paper manufactures	0.1*	0.4	0.6
Heat, light and power	4.4	7.9	6.8
Stone, clay, glass etc.	2.4	2.5	2.4
Metals other than precious	4.0	4.1	5.1
Precious metals	0.2	0.1	0.1
Books and publications	4.1	5.1	4.3
Ornaments etc.	0.2	0.1	0.1
Machines, tools, and implements	1.1	1.2	1.5
Carriages and vehicles	2.0	3.3	5.2
Harness, saddling and leatherware	4.7	1.9	0.9
Ships, boats and equipment	0.9	0.6	0.6
House furnishings	1.8	1.8	1.8
Chemicals and by-products	0.5**	2.5	2.9
Textile fabrics	1.7	1.2	1.0
Apparel	8.1	5.1	5.4
Fibrous material	1.1	0.7	0.4
Industries with output unspecified because of smallness of numbers	3.2	-	-
Miscellaneous	0.4	0.3	0.5
	100.0	100.0	100.0

Total value, old statistical series, 1920-21, £82,500,000; 1929-30, £91,900,000.
Total value, revised statistical series, 1920-21, £77,800,000; 1929-30, £90,800,000; 1938-39, £114,400,000.

* Excluding paper milling, because of small number of units.

** Excluding several industries because of small number of units.

Despite the fact that the pattern of manufacturing had changed little, what changes there were pointed to a tendency to be accentuated in following years. The indus-

tries that expanded were those relying more on imported materials. The 1920s showed that the benefits to the manufacturer of a growing market will be limited if he is not assured of a substantial share of that market. The depression of the 1930s underlined a fact that remains most important: New Zealand's industries, and particularly the consumer industries, depend on a growing market and sustained purchasing power.

THE WAR AND POST-WAR YEARS

From the late 1930s to the early 1950s, New Zealand progressively substituted its own manufactures for imports of consumer goods - goods that could not be imported, in many cases, because of war and post-war shortages. It was the war that gave a fillip to New Zealand manufacturing - shortages, and a high and rising level of demand opened the way for growth in all industries, but particularly those making consumer goods. Full employment and the assurance of a substantial part of the market, given by successive administrations throughout the period up to the present, were the primary factors that built New Zealand industry.

Table 7.2 carries forward the comparison of the patterns of manufacturing output from 1938-39 to 1945-46 and again to 1958-59. The third column of figures has been revised to exclude "heat, light and power" and to amalgamate certain industry groups to bring them into approximate comparability with the re-grouped statistics for 1958-59.

Table 7.2 shows that, over the whole period, the industries processing imported raw materials made the greatest advance, particularly those making "machines, tools and implements" and the transport industry (now mainly the assembly and repair of motor vehicles). A notable exception was of course paper manufacture, which used New Zealand timber for its development. In the more recent statistics the "machines, tools and implements" industry, to reflect the changing times has been re-named and divided into "machinery except electrical" and "electrical machinery and appliances". The first category includes such consumer products as refrigerators, washing machines and lawnmowers (in addition to agricultural and some industrial machinery) and the second includes ranges, radios and electric toasters, irons, jugs and kettles, radiators, vacuum cleaners and lamps. The expansion of the chemicals industry too has depended on greatly increased imports of raw materials, particularly for the manufacture of plastics, paint and rubber.

In 1938, just over 43 per cent of New Zealand's imports by value were producers' materials. In 1958, the percentage was just over 56 per cent. Table 7.3 gives from 1932 onwards the percentages for this category and for

"producers' equipment", "transport equipment" and "consumers' goods."

TABLE 7.2
VALUE OF FACTORY PRODUCTION IN NEW ZEALAND

	1938-39 per cent	1945-46 per cent	1945-46 Revised per cent	1958-59 per cent
Animal food	43.2	34.7	42.4	36.7
Vegetable food	5.6	5.1		
Drinks, narcotics and stimulants	3.7	3.9	4.1	2.8
Working in woods	5.7	5.6	8.0	8.0
Furnishings	1.8	1.9		
Paper manufactures	0.6	0.7	0.7	4.5
Heat, light and power	6.8	6.1	-	-
Processing relating to stone, clay, glass	2.4	1.6	1.7	3.3
Metals	5.1	6.1	6.5	4.5
Books and publications	4.3	3.2	3.4	3.6
Machinery, tools and implements	1.5	2.7	2.9	6.2
Carriages & vehicles	5.2	3.9	4.9	9.6
Ships, boats, etc.	0.6	0.5		
Animal matters	2.0	3.1	7.0	6.8
Other chemicals and by-products	2.9	3.5		
Textiles and fibres	1.4	1.3	1.3	4.8
Apparel and footwear	5.4	8.1	9.2	7.8
Harness, saddlery and leatherware	0.9	0.6		
Other Industries	0.9	7.4	7.9	1.4
	100.0	100.0	100.0	100.0
Total value of production (millions)	£114.4	£195.3	£183.6	£659.4

Table 7.3 shows how, over one-quarter of a century, New Zealand reduced the proportion of consumer goods imported. In 1932, almost one-third of imports were consumer goods; in 1958, less than one-sixth. So much has New Zealand reduced its dependence on them that it is doubtful whether, with the present size of the market, New Zealand can rely on import substitution in consumer goods as a major source of industrial expansion in the near future.

In 1958 imports classified as consumer goods represented 15 per cent of the total of all imports and were valued at £42,000,000. An analysis of the figures shows that of this total, food imports represented 14.2 per cent, beverages 11.9 per cent, tobacco 1.3 per cent, clothing and accessories 10.8 per cent, household equipment 24.8 per cent and "other" 37.1 per cent. In this latter category are included jewellery, books and other printed matter, sports goods and pharmaceuticals. Compared with other smaller countries of high living standards the proportion of consumer goods imported is high, but judged by the experience of the Department of Indus-

tries and Commerce over the past two years it seems unlikely that New Zealand can expect any radical change in the import pattern. Put in another way, the majority of imported consumer goods, as defined by the Department of Statistics, are generally of a kind which cannot at present be produced economically in New Zealand and must be imported. There are exceptions, of course, particularly with food and beverages.

TABLE 7.3
PERCENTAGES OF IMPORTS CLASSIFIED ACCORDING TO PURPOSE

Year	Producers' Materials*	Producers' Equipment	Transport Equipment	Not Classified	Consumers' Goods
1932	54.56	7.95	6.79	0.00	30.70
1933	54.69	7.97	7.02	0.02	30.30
1934	50.45	8.42	12.26	0.04	28.83
1935	48.31	10.20	13.77	0.15	25.57
1936	46.91	12.11	14.24	0.24	26.50
1937	44.75	12.87	14.65	0.37	27.36
1938	43.47	14.20	15.13	0.56	26.64
1950	55.75	17.33	8.72	0.55	17.65
1951	54.14	15.78	9.59	0.37	20.12
1952	52.88	17.29	12.05	0.84	16.94
1953	51.51	19.15	9.66	1.62	18.06
1954	52.08	17,23	11.22	0.91	18.06
1955	51.74	17.85	11.84	0.67	17.90
1956	51.81	18.31	10.59	1.05	18.24
1957	52.59	18.39	10.35	0.68	17.98
1958	56.10	18.70	9.33	0.76	15.10

* Including fuels and lubricants and auxiliary aids to production.
Source: "Report on and Analysis of External Trade Statistics for the Year 1958."

There is some scope for expansion, however, and in the main this is already taking place. Expansion of old rather than the growth of new units has been the general rule in the food producing industries. The last decade has seen expansion of flour milling into cornflour and egg noodle making, of canned foods into baby foods and packaged soups, etc, and biscuit manufacturing into new brands of products previously imported. Two fairly important, relatively new consumer industries are those of instant coffee manufacturing and packaging of crayfish tails for export. The manufacture of gin for New Zealand consumption and special types of beer for the export market are further examples of both the development of new and expansion of existing consumer enterprises (and the making of brandy for sale has been discussed recently at the Industrial Development Conference, June, 1960). Some of the recent developments in the food industry are directly related to the new demands generated by European immigrants.

The textile industry has developed significantly in the last few years. New Zealand-made wool jersey cloth has replaced the imported article. In the last two years rayon

and nylon underwear fabrics, using imported synthetics processed in New Zealand, have been gradually meeting the New Zealand demand. Warp loom knitting, using imported rayon and nylon is expected to supply the whole New Zealand market by 1961 except for a few special types, compared with only four years ago when all warp loom fabrics were imported.

There was, too, an expansion in variety and quantity of all kinds of woollen goods made in New Zealand following the re-introduction of import licensing of woollen piece goods in 1955. At present the New Zealand industry supplies 60 per cent of requirements of yarn and piece goods. There is further scope for improvement of this figure.

Carpet manufacturing is another textile industry in which recent expansion has reduced dependence on the imported finished product. New and expanded firms should be meeting practically the whole of New Zealand's needs by 1961. In 1957-58 two enterprises, one in Auckland and one in Wellington, began making tufted carpets for the first time in New Zealand. Using half New Zealand wool and half rayon yarn they are producing tufted carpets of a quality at least comparable to that of the imported product, and often better because a larger proportion of wool is being used. It is very likely that these units and the new factories producing woven carpets this year, could develop an export trade in New Zealand-made Axminster, Wilton and tufted carpets.

In the textile field perhaps more than any other type of consumer industry, the possibilities of new developments and further expansion in the future seem to be of great significance.

Less spectacular growth has taken place in the ceramics and glassmaking industries. But in the last four or five years the Auckland potteries have extended production in range and have introduced new designs (they are now promoting further improvements in design) while in glass manufacturing increased mechanization is bringing about a better quality of glassware. Production is still generally limited to medium quality utility and decorated ware. With a growing market and the introduction of more skilled craftsmen to both industries, however, there is every chance that the range of their products could be widened.

Some important extensions have also taken place in the paper-using industries. Printing and publishing, a New Zealand industry long in existence, has grown substantially in recent years, while the wallpaper industry which has started mass production this year is another important development incorporating a large New Zealand content. This industry will soon be in the export trade.

Radios and most of the major appliances have been made in New Zealand for many years. In the last two or three

years, however, plans have been made for expansion in these fields. Production of television receiving sets has already begun in Auckland, Wellington and Waihi.

The expansion of household appliances manufacturing in the last two years has been significant. Industries which have been developed recently include those making, or intending to make in the near future, fluorescent tubes, floor polishers, toasters, electric shavers, and domestic sewing machines. Other new, expanded or proposed production over the last two years includes gramophone records, some musical instruments and ballpoint pens. The present expansion into new fields and the high efficiency of firms in this industry have been achieved within the framework of import selection which has provided a favourable environment and assured a determinable share of the market. This assurance of the market has been present with some minor exceptions, continuously since 1938. (See Appendix 7.1, page 181.) The consumer has benefited from the usually competitive supply of a wide range and excellent quality of product, and from prices which in many cases have been kept stable, or which have been reduced.

NEW ZEALAND CONTENT

The growth of consumer industries that took place before the exchange crisis of 1957 was a valuable prelude — indeed a prerequisite - to the making of components in New Zealand. This growth provided training in the techniques of production and distribution: it developed the changed system of distribution necessary for products made in New Zealand, it developed the packaging and printing industries, it changed the attitude of the banks to manufacturing in New Zealand, it trained management and built assembly plants. But, largely because the New Zealand factories were providing mainly the final processing operation, the value added was not high. The following table, covering many important consumer industries, shows that, as a percentage of the Gross National Product, the value added by these industries over the last 20 years has risen insignificantly, although it has increased absolutely.

DEPENDENCE ON IMPORTS

Examples of New Zealand's heavy dependence on imports can be seen if we examine some specific industries. Taking into account the fact that the electrical appliances industry obtains many of its components from other New Zealand manufacturers who themselves use a combination of domestic and imported raw materials, the Department of Industries and Commerce has calculated that 16 manufacturers of household electrical appliances with a production of just over £7,500,000 in 1955-56, used materials and components valued at £4,600,000; of this amount £3,400,000 was the approximate

value of imported components and raw materials. This represents about 45 per cent of the factory value of the products.

TABLE 7.4
VALUE ADDED BY CONSUMER INDUSTRIES

Year	G.N.P. £(million)	Value added by Consumer Industries* £(million)	Per cent of Added Value to G.N.P.
1938-9	232	21	9.1
1946-7	425	44	10.3
1953-4	842	83	9.8
1954-5	933	91	9.7
1955-6	986	96	9.6
1956-7	1,029	94	9.1
1957-8	1,084	109	10.0
1958-9	1,137	114	10.0

* The class of factories chosen to represent consumer industries are: food, beverages, tobacco manufacturers, textiles, footwear, other wearing apparel and made-up textile goods, furniture and fittings, printing, publishing etc. electrical machinery and appliances.
Source: Department of Statistics: "Industrial Production Statistics 1938-39 and 1946-47." "Factory Production Statistics 1953-54 to 1958-59".

Some of the more important raw materials and components imported for this industry are screws, nuts, washers, fuses, porcelains, copper wire, tubes from the United Kingdom, electric motors from U.S.A., insulation material, steel sheet and range elements from Australia. Many of these materials and components can be or will be made in New Zealand. Although the total imported content in household electrical appliances averages 45 per cent, figures from various manufacturers range up to 70 per cent.

The annual use of raw materials by 12 major manufacturers of tyres, tubes and rubber goods is about £3,200,000, natural rubber accounting for £1,600 000, latex £300,000, and synthetic and reclaimed rubber £100,000. The import content in the finished product is approximately 60 per cent. Some of the more important raw materials imported for the industry are sulphur, carbon black, clays and whiting and tyre fabrics from the United Kingdom and U.S.A., natural rubber and latex from Malaya, and synthetic rubber from U.S.A. Many of these raw materials cannot be produced in New Zealand, but when the market is large enough we can expect the production here, for example, of synthetic rubber, as a by-product of the proposed oil refinery. Information from manufacturers indicates that the New Zealand content of tyres, tubes and general rubber goods ranges up to 70 per cent of factory selling price.

In 1956 imports of thermosetting and thermoplastic resins for the plastics industry were valued at £1,300,000, 50 per cent of the total value of plastic goods production. Again, a larger market could lead to the possible development

of plastics raw materials from New Zealand's mineral and electric power resources.

Recent trends in footwear manufacturing indicate a move towards a higher imported content. An industry which once used almost wholly New Zealand raw materials, footwear manufacturing is now using synthetic products for soling instead of leather. Recent changes, therefore, are away from further development in depth by the use of indigenous materials. The additional factor that New Zealand is supplying to the footwear industry is skill. New Zealand is, under royalty arrangements including Italy, the United Kingdom and U.S.A. developing a competitive, high-quality industry.

Outside the Department of Statistics classification of "consumers' goods" stand two large categories of imported goods, a large part of which could properly be considered consumers' goods - motor cars and cotton fabrics. In 1959, imports of the former totalled in value £8,000,000 and the latter approximately the same amount. In these two spheres there is considerable room for New Zealand manufacture and the Department of Industries and Commerce is at present negotiating to that end. Projects being considered involve increases in the number of motor vehicle components made in New Zealand, in the New Zealand content of other components and in the amount of assembly done in New Zealand. Another change in the motor vehicle industry is the forthcoming manufacture in New Zealand of motor scooters which will have a high New Zealand manufacturing content.

A cotton industry for New Zealand has been discussed ever since the war years. Now it is to begin; a cotton spinning and weaving mill is to be built in New Zealand.

THE LIMITS OF CONSUMER INDUSTRIES

I have suggested that, while some further expansion can be expected in the range of consumer goods made in New Zealand, that cannot be regarded as the major source of industrial expansion, particularly as the range of replaceable imported consumer goods is diminishing. There is another reason why rapid expansion cannot generally be expected in consumer industries, namely the limitations of the purchasing power of the public. The rise in production of several consumer goods industries is shown in Figure 7.1.

The short-term fluctuations in the graphs are attributable to a variety of causes, but mainly to import competition and changes in purchasing power. The long-term trend in the industries chosen shows consistently an initial steep rise in production followed by a slower rate of increase. This is what we would expect. At first the industry starts making a product which was formerly imported, or which could not be made earlier because of lack of demand or war-time shortages of materials, or a product which is the result of a

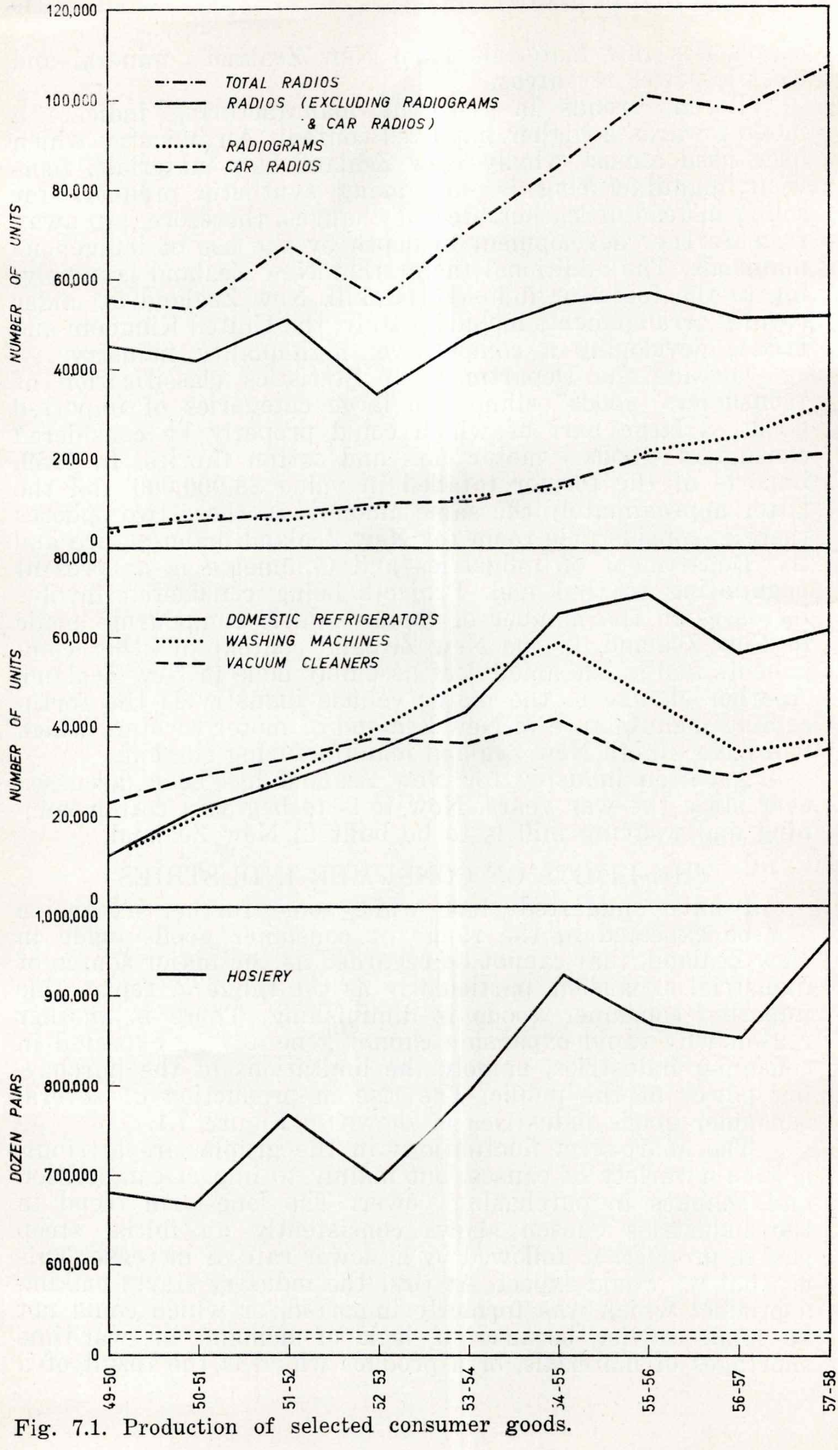

Fig. 7.1. Production of selected consumer goods.

new technical development. As long as the market is assured to the industry, production rises to the point of full supply of the market. After that, sales of the product depend on an increasing population, on a rising standard of living and on replacements.

The graph illustrating radio production is an interesting example of the development of new products from much the same group of manufacturers. The curve for radios has flattened, but those for automobile radios and, later, radiograms have continued to rise with rising living standards. In the future television sets will be added to this group, but they will also probably reduce the demand for other durable goods. As the standard of living rises, demand for the older products can be revived. For example, although a family may have a car radio, radiogram and tape recorder, rising or changing living standards may also demand a portable radio or radios in the kitchen and children's rooms. A recent further example is the development of the "stereogram".

Even taking these qualifications into account, the fact remains that the demand for the products of the consumer industries tends to level off and this, taken with the fact that the present range of import substitution of consumer goods is substantially diminished, indicates that New Zealand cannot rely on consumer industries for the required rate of industrial expansion.

If we place these alongside the further fact that many consumer industries rely heavily on imported components, one obvious solution is that part of future development must lie in the increasing manufacture in New Zealand of the components themselves. Events of the last two years have shown that this kind of development is possible and economic.

THE SIZE OF THE MARKET

The limits imposed on the expansion of consumer goods industries will be less restrictive the more population increases; an accelerated rate of increase can come through immigration. The Industrial Development Conference emphasized the point that if we are to have the skills necessary for development we shall need a substantially accelerated rate of immigration of skilled persons. I would add to this that only by enlarging the total market can New Zealand move into some fields of industrial expansion.

The size of the market, too, affects the growth of another class of consumer industry - services. This type of industry is based almost entirely on a New Zealand resource, human skill. But New Zealand's relative backwardness in services - for example, entertainment - can be cured partially by a conscious development of the required skills, particularly through the education system, and by community support especially for the arts. As a result of the slow growth of New

Zealand's entertainment industry one consumer service, television, is likely to have a high import content in its final product, the programme.

I have mentioned that immigrants from European countries have already enriched our range of foodstuffs by new demands. Increased immigration can contribute not only to a larger total demand, but to a wider range of demand, and to the skills required to satisfy those demands.

Given an assurance of a substantial share of an expanded market in New Zealand some industries will be able to export. I have already referred to the possibility of exports of carpets and wallpaper, for example: we can develop a trade in manufactured consumer goods if New Zealand skills can provide high-quality products of distinctive design unique to New Zealand, just as other countries approximating our national income have done.

THE ROLE OF IMPORT SELECTION

With the assurance of a substantial part of the New Zealand market, the consumer industries will also be able to produce a greater variety of goods, and indeed will be obliged to if internal competition is permitted full play. Many New Zealand industries have already extended widely in variety and range and it is probably true to say that in many fields the consumer has as wide a choice as he would have had under a policy of unrestricted importing. Such a policy would be accompanied by the unemployment characteristic of the 1920s. There is a strong motive for manufacturers, because of strong internal competition, to seek out royalty agreements with overseas producers of international brands in an attempt to produce something different from, and better than the goods of their competitors. This could not have been done if imports had taken a substantial part of the market. The existence of import control for over 20 years has encouraged a greater variety in New Zealand's consumer goods than would otherwise have been possible; particularly is this true of the period of the 1950s. It is as true of the garment trade as it is of the food trade.

In the last 20 years there has been a quiet and unsung revolution in New Zealand's consumer goods industries. The first aspect of this has been in quality, the second in number, range and variety. There are several reasons for this, but the most important and basic one is the fact that in New Zealand's vulnerable economy the policy of full employment combined with high living standards produces an almost chronic balance of payments problem.

The rationing of overseas funds that this necessitates brings sharply to the fore the need for decisions on priorities. What imports shall come in and in what order of importance? New Zealand makes so few basic textiles, chemicals and

pharmaceuticals, so little machinery and equipment, grows so little tropical and sub-tropical produce that, if it did not allocate scarce overseas funds to essential needs, there is no guarantee that these needs would be met. In fact, there is a certainty that they wouldn't be. This was obvious enough in the war and post-war years of stringent scarcity when we were so often lucky to get imports at all and New Zealand industry had to make up the balance. But it was true of the 1950s and it will be true of the 1960s so long as full employment is the rule.

The post-war scarcity ended about the end of the 1940s. The war in Korea and the generally good prices for basic commodities such as wool which continued through the middle 1950s gave New Zealand unprecedented prosperity. It was a period which could not be duplicated in New Zealand's economic history and, despite the prosperity, there were violent fluctuations for New Zealand. The balance of payments problem remained. Subject to the exigencies of the balance of payments, policy was to permit as much free importing as possible. This made the economic climate much more rigorous for some industries, particularly manufacturing industries. Some, such as those making vacuum cleaners and domestic irons, almost disappeared; others were diminished.

But unrestricted competition from imports was only partial. For the great majority of New Zealand consumer industries the market was there, for import control remained. The number of commodities continuing to be subject to import control throughout the 1950s is so substantial that I have included it as Appendix 7.1 of this paper. (See page 181.) This appendix sets out the items or commodities which have been assured a share of the New Zealand market through import control by successive administrations from 1938 to 1957, the year of the severe balance of payments crisis.

These items include almost all agricultural, horticultural and pastoral products, a high proportion of footwear, leather, rubber, plastic, paper, building, clothing, drapery and textile products and a proportion of sporting goods, light durable goods, electrical goods and chemical goods. The products range from crown seals and fireworks to printing ink and motor vehicles. This does not mean that the whole market has been in every case assured to the New Zealand farmer or manufacturer. In the majority of cases of manufactured products a proportion of imports has been provided for.

New Zealand's social policies of full employment and well-spread and high living standards have for over 20 years demanded more imports than the country could pay for. The result has been a development of industry more varied and deeply rooted than otherwise could have possibly occurred

had not import control led to the necessity of maximum production from within New Zealand.

The early 1950s were a time when New Zealand manufacturing industry could be put to the test. New Zealand was prosperous; there was a continuously heavy demand for labour; there was a need to seek lower costs, the best methods, the best article. There was an element of uncertainty which always accompanies a check, but there was full employment and a high demand for consumer goods, and a substantial number of New Zealand produced goods remained assured of a market.

And what is more, New Zealanders continued to have more goods to maintain living standards because of the increased New Zealand production that came about in order to supply the market. The foreign exchange saved was substantial.

EXCHANGE SAVED BY NEW ZEALAND PRODUCTION

It would take long and complicated research to show the total net saving in foreign exchange as a result of import selection and consequent expansion of the market for New Zealand industry. But to give some indication of the order of saving made by specific manufacturing groups, tables for five industries covering the eight years 1950-51 to 1957-58 are given in Appendix 7.2. (See page 187.)

In working out the figures I have assumed that all the materials and all the plant and machinery used by the industries specified have been imported and paid for out of exports. This is clearly an exaggeration but it tends to offset my other assumption that the imported finished product - if it had entirely replaced the New Zealand product - would not have been lower in price. Whether the net result comes out one way or the other makes little difference because exchange savings that have resulted are so substantial.

Table 7.5 summarizes (in round figures) the tables given in Appendix 7.2.

TABLE 7.5

EXCHANGE SAVINGS MADE BY FIVE NEW ZEALAND INDUSTRIES

(Eight years 1950-51 to 1957-58)

Radio assembly	£7,200,000
Clothing industry	£86,200,000
Rubberware	£24,500,000
Paint and varnish	£9,300,000
Electrical appliances	£18,000,000

Remember that these figures are based on an assumption of entire replacement of the New Zealand industry by imports. This, of course, is a hypothetical situation, but the figures are of sufficient size to indicate that savings of ex-

change are substantial whatever might have been the level of production of New Zealand industry if New Zealand had had in the 1950s the social and economic policy of the 1920s when any balance of payments problem was worked out in unemployment.

I should add that in examining proposals for new industries the Department of Industries and Commerce carefully analyses the estimated net exchange savings, and the industries recently established or proposed will achieve an even greater proportion of savings of overseas funds than the consumer industries I have used as illustrations.

PRESCRIPTION FOR THE FUTURE

To summarize, the prescription for consumer industries is to enlarge and broaden demand by a faster growth of population (and at the same time to gain new skills from immigrants); to produce in New Zealand more of the materials and components for consumer goods (and again a larger market will speed this process); to encourage the development of goods based on new techniques and materials, if necessary adapting those innovations to New Zealand needs and resources; to encourage the development of consumer services, particularly those arising from the arts; and to promote the export of consumer goods made in New Zealand. Each one of these aims will depend for its fulfilment on the assurance to producers of a substantial share of the New Zealand market.

Let me now examine briefly some recent developments in consumer industries to assess whether they are in line with the prescription. A most welcome recent development has been the recognition that the arts need more public support, and the increasing of the amount available from the government for this purpose. The Industrial Development Conference gave heartening support to the case for the improved development of the arts, entertainment, community services and other "non-material" aspects of the standard of living. The Prime Minister in his opening address said: "I hope that this conference will not conclude that when the way has been opened for more houses and carpets, more cars and television sets, the work has been done. A standard of living based on these things can be a low one. It can be accompanied by a social disposition of surfeit and boredom: a feeling that all has been achieved and that satisfactions lie in competitive consumption and a quest for shallow stimulants. Such a standard can be lower than that of the peasant or tribesman."

The conference also called for improvements in civic amenities, such as parks, gardens, museums and public buildings. We need only to look at parts of, say, Washington,

Paris or London to see how conscious efforts towards beauty and dignity in the planning of the centre of the city and its environs can yield such rewards in satisfaction to the "consumer."

The new developments in physical production of consumer goods[1] conform with the prescription. They will all replace existing imports, or goods that would have been imported. They will all produce, or have a programme to produce, with the maximum New Zealand content economically possible in present circumstances. I need refer only to two examples, the wallpaper industry and the oil refinery, which will use a raw material imported in crude form.

The output per worker and per unit of capital employed in the new and expanded industries will be high, and they are being established on the understanding that their prices will be comparable with those of imported products - many of them equal or down in price, some slightly higher. Their quality will be equal to, sometimes better than, that of the imported article. The range of choice for the consumer will be considerably extended by many developments. Some of the new consumer products will be exported. A start has been made, but in the consumer field there is still a lack of products based on technical and design skills peculiar to New Zealand.

EXPORT PROMOTION

The industrial development policy with which the Department of Industries and Commerce is involved is always integrated with the promotion of exports. New Zealand at any particular time has a more or less fixed amount of foreign exchange to spend on imports. The development of New Zealand industry lessens reliance on imports but it does not reduce the level of imports. They merely become different in type; if New Zealand imports fewer garments it imports more machinery[2].

In investigating the possibilities inherent in changing the pattern of imports, trade reciprocity is always in mind. But one of New Zealand's difficulties is that though our markets will increasingly be in the Far East, most of our potential trading partners have undeveloped economies. In this century New Zealand's new trading area - in addition

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1. Set out in the supplement "New Zealand's Manufacturing Development since 1 January 1958" to W. B. Sutch: "Programme for growth" read to the Industrial Development Conference, 13 June, 1960.

2. I have shown by the examples in Appendix 7.2 that, if industry had not advanced, the drain on overseas funds would have been greater and less exchange would have been available for imports of goods that cannot be made in New Zealand. The total volume of goods available for use would have been less, therefore, and the standard of living in New Zealand would have been lower.

to the United Kingdom, North America, Australia and Continental Europe - will be in the region to the north of us, including Japan, China, the Philippines, Indonesia, Malaya, Singapore, Burma and other Southeast Asian countries. There is some merit therefore, in so shaping New Zealand's own internal economic development that it enables easy trade reciprocity and perhaps the development of a regional trading arrangement among the countries of Asia and the Southwest Pacific. The difficulty is that it is always hard to know in advance what are to be the specialties of countries still at an early stage of industrial growth. Harmonizing of development policy should nevertheless always be borne in mind. For the years ahead we at least know this - that the kind of industries on which we should concentrate are not so much the mass production industries but those that require high skill.

INDUSTRIAL DEVELOPMENT WITHIN THE AUCKLAND METROPOLITAN REGION

David Carr, Ph.D., M.A., B.Agr.Sc.*

Throughout the world there has been a rapid increase in industrial development since the end of World War II, and this rate of expansion must continue if the requirements of 5,000,000,000 people are to be met by the turn of the century, and if the living standards of the world are to be raised during this period. The population of New Zealand will reach 5,000,000 by the year 2000 - 0.1 per cent of the world's population - and it is essential that our own economy become more diversified with a greater emphasis on industrial expansion if full employment and a continued increase in our standard of living is to be maintained.

The world-wide trend in industrialization has also been apparent in New Zealand, more especially during the past three years. Industrial development within the Auckland Metropolitan Region is a part of the overall regional and national development, and can be assessed adequately only in the context of that development. It is, therefore, necessary to examine in general terms the structure of the New Zealand economy before dealing in more detail with development within the Metropolitan Region.

New Zealand's dependence upon pastoral and agricultural products is shown in Table 8.1 which lists the main items exported from New Zealand in 1959.

If New Zealand were not to diversify her economy and continued to rely almost entirely upon primary production, it is unlikely that the present standard of living and increase in population could be maintained over a long term period. During 1959 the only export items from secondary industries not processing primary products were manufactured goods valued at less than £1,000 000. The present lack of industrial development is illustrated by the fact that of the goods available for use in New Zealand approximately 40 per cent are imported. This figure compares with 30 per cent in Canada, 29 per cent in Australia, and 14 per cent in the United

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Kingdom. The dependence upon primary production is also reflected in the relative absence of industrial research centres, design schools and technological institutions.

TABLE 8.1
NEW ZEALAND EXPORTS, 1959.

	£(millions)	%
Wool	98.5	32.2
Meat	73.7	24.1
Butter	60.4	19.7
Cheese	21.9	7.2
Sheepskins and pelts	8.4	2.7
Milk by-products	7.1	2.3
Wood products, pulp and paper	6.3	2.1
Hides and skins	4.8	1.6
Casein	4.4	1.4
Sausage casings	3.7	1.2
Tallow	3.6	1.2
Honey and fruit	2.5	0.8
Timber	2.1	0.7
Seeds and peas	1.9	0.6
Fish and fish oils	1.6	0.5
Foodstuffs	1.3	0.4
Meat by-products	0.8	0.3
Livestock	0.2	0.1
Manufactured goods	0.6	0.2
Sundry	2.1	0.7
	305.9	100.0

Source : Reserve Bank Bulletin, February, 1960.

It is essential that local industries are developed which can help to reduce the propensity to import, and industries which would increase the present volume of exports should also be encouraged. Although at present nearly all industrial output is dependent upon the export of farm products the relationship between primary and secondary production in New Zealand is interdependent and complementary. It is necessary that industrial development be considered in relation to other aspects of development including primary production, population growth and the provision of services and amenities. The impact of industrialization and a rapidly growing urban population demands a more rational approach to national development in New Zealand.

Perhaps the most important single factor which has accelerated both urban and industrial growth in this country is the increase in the number and the use of motor vehicles. Table 8.2 shows the rapid increase in the number of vehicles registered in New Zealand and the Auckland Metropolitan Region. The total number of vehicles registered in New Zealand increased from 226,800 in 1936 to 843,000 in 1960, and the number of persons per vehicle decreased from 6.9 to 2.8 during the same period. During the past decade there has

been an increase of approximately 100 per cent in the use of commercial road transport by individuals and organizations in New Zealand.

At present approximately 60 per cent of the New Zealand population lives within 14 main urban areas. In 1926 59.3 per cent of the European and 8.7 per cent of the Maori population were urban dwellers. By 1956 the respective proportions had risen to 65.1 per cent and 23.6 per cent.

TABLE 8.2

NEW ZEALAND AND AUCKLAND METROPOLITAN REGION POPULATION AND MOTOR VEHICLE REGISTRATION.

	POPULATION			VEHICLES		
Year	N.Z.	Auck Metropolitan Region	%	N.Z.	Auck Metropolitan Region	%
1936	1,573,000	264,000	16.8	226,800	38,340	16.9
1945	1,702,000	329,000	19.3	314,500	55,620	17.7
1951	1,939,000	387,000	20.0	447,400	79,700	17.8
1956	2,174,000	428,000	19.7	674,300	124,300	18.4
1960	2,370,000	487,000	20.5	843,000	162,000	19.2

	PERSONS PER VEHICLE	
	N.Z.	Auck Metropolitan Region
1936	6.9	6.9
1945	5.4	5.9
1951	4.3	4.9
1956	3.2	3.5
1960	2.8	3.0

It is estimated that the population of New Zealand will reach approximately 3,600,000 by 1980 and more than 5,000,000 by the year 2000. Primary production must increase sufficiently to supply this increase in population and provide overseas funds for the necessary increase in imports. Assuming that the terms of trade remain substantially the same as at present, and assuming a minimum annual rise in the standard of living of 1 per cent, the volume of farm production will have to rise at a faster rate than the population.

The total area of New Zealand is approximately 66,000,000 acres of which less than 43,000,000 acres are occupied. Most of the land which is not occupied and which could be brought into use could only be developed by special

methods and at a considerable capital cost. Of the area in occupation approximately 20,000,000 acres have been improved and the remaining unimproved land consists mainly of tussock and native grasses, fern, scrub, second growth, native bush, and barren and unproductive areas. This unimproved land is capable of increased productivity but very little of it could be classified as arable. However, although the areas of good arable land in New Zealand are very limited and it is estimated that there are only 2 000,000 acres (3 per cent) which are of high natural fertility, it is possible for farm production to expand sufficiently to meet the requirements of the population during the next 40 years.

New Zealand has reached its present stage of development after 120 years and within the next 40 years our present population of 2,370,000 will have more than doubled. It is likely that the present decade will see a very rapid rate of growth of industry in New Zealand, and, assuming that this rate of increase in industrial expansion continues, it is probable that the amount of economic development during the next 40 years will be in excess of that of the past 120 years. New Zealand has recently entered a stage of transition during which her economy will change and the role played by industry will assume increasing importance. Some of the major facts of this industrial development have been discussed in earlier chapters of this book.

The change in the pattern of manufacturing between 1920 and 1939 was not very significant, but between 1939 and 1959 there were certain marked changes and during this period the value of machinery and implements manufactured rose from 1.5 to 6.2 per cent whereas the value of animal food processed fell from 48.8 to 36.7 per cent of the respective totals. During this period the growth of the pulp and paper industry was reflected in the rise of paper manufacturing from 0.6 to 4.5 per cent. Forest industries based on exotic timber resources are expanding at a very rapid rate. The production of pulp, paper and board is increasing by more than 10 per cent per annum and additional capital is being invested in these industries in order to develop further capacity. The pulp and paper industry now represents an investment of more than £40,000,000 with an installed output capacity of approximately £20,000,000 of products annually. Exports of pulp and paper products in 1959 were in excess of £5,500,000, and the industry at present employs more than 4,000 workers.

Today there are 70,000 more persons employed in manufacturing than in primary industries and more than 220,000 persons, or 25 per cent of the total labour force, are now employed in the manufacturing sector of our economy. The

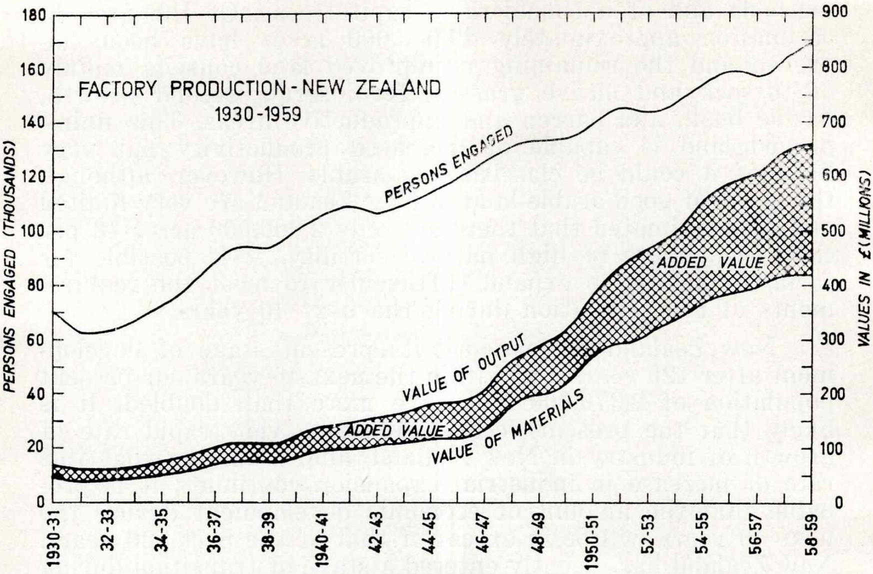

Fig. 8.1. Increase in factory production in New Zealand, 1930 to 1959.

contribution to the national income by these industries is nearly 30 per cent of the total physical production and the value added represents 20 per cent of the gross national product. The volume of industrial production has been increasing steadily as is shown in Figure 8.1. The great increase in more recent years has been in industries processing imported raw materials. Between 1936 and 1954 these "non-indigenous" industries increased their number of workers by 179 per cent and their volume of production by 400 per cent compared with "indigenous" industries which increased their labour force by 57 per cent and their volume of production by 76 per cent.

In the coming years, the expansion of industry will be more rapid than in the past and the percentage of the labour force in manufacturing will have to increase steadily if adverse economic effects are to be avoided. The total labour force and the distribution of that force in the various branches of employment in the future will have considerable significance when considering national and regional development. For the purpose of this paper it is assumed that the rise in labour force will parallel the rise in population and Table 8.3 sets out the percentage distribution of the labour force in New Zealand in 1946, 1956, 1958 and the projected distribution in 1978.

TABLE 8.3

NEW ZEALAND LABOUR FORCE
PAST AND PROJECTED DISTRIBUTION

	Percentage Distribution			
	Oct. 1946	April 1956	April 1958	Projected 1978
Primary	21.7	18.6	17.0	12.6
Building & Construction	7.1	8.7	9.3	9.0
Power, water, and Sanitation	1.3	1.4	1.4	1.5
Other services (Finance, distribution, transport, administration, etc.)	44.1	45.6	46.4	47.1
Manufacturing	23.7	24.5	24.7	29.0
Armed Services	2.1	1.2	1,2	0.8
	100.0	100.0	100.0	100.0

Sources: Labour and Employment Gazettes and W. B. Sutch: "Education for Industry," September, 1959.

The number of persons engaged in the various industrial groups in 1958 and the projected distribution of the labour force in 1978 is shown in Table 8.4.

These projections recognize that a limited proportion of the increase in the labour force will be absorbed by the farming industry and this projected distribution assumes that the manufacturing industry will absorb all the labour not required by other industries. On those assumptions, therefore, during the next 20-year period 1958-78, an additional labour force of approximately 150,000 would be available for manufacturing industries - this would represent the equivalent of an additional 3,000 factories each employing 50 workers, and would amount to an average increase in manufacturing employment of approximately 7,500 persons per year. The annual increase in the number of employees in the manufacturing industries has been averaging less than 6,000 per year, and the conclusion to be drawn from the above figures is that an adequate labour force will be available for a sustained expansion of manufacturing industry after allowing for the necessary and probable requirements of other industries.

Some of this industrial expansion will be based on a greater use of New Zealand materials and skills, on the use of more New Zealand made components and on the processing to a more final stage of the country's own primary products, including meat and wool. However, the expansion of industries processing domestic raw materials will be limited and the required expansion of manufacturing in New Zealand must be sought, therefore, mainly in industries using imported raw materials.

The number of projects involving a capital expenditure of £10,000 or more - new factories and the expansion of ex-

isting factories - which were commenced or planned in New Zealand between January 1958 and June 1960, totalled approximately 240 and represented a capital investment of more than £70,000 000. These projects included an aluminium fabricating plant, a steel rolling mill, a wire rope factory, a soluble coffee plant, a gin distillery, a cotton weaving mill and an oil refinery. Since June 1960 it has also been decided to establish a copper mill in New Zealand.

TABLE 8.4

NEW ZEALAND LABOUR FORCE
PROJECTED AMOUNT AND DISTRIBUTION

Industry	1958		Projected 1978	
	No.	%	No.	%
Primary	145,000	17.0	160,000	12.6
Building and construction	79,100	9.3	115,000	9.0
Power water and sanitation	12,200	1.4	19,500	1.5
Other Services (Finance, distribution, transport, administration, etc.)	394,100	46.4	598,000	47.1
Manufacturing	210,200	24.7	369,500	29.0
Armed Services	9,900	1.2	10,000	0.8
Total Labour Force	850,500	100.0	1,272,000	100.0
Total Population	2,276,000		3,448,000	

	Increase		
	No.	% increase	% share of total increase
Primary	15,000	10.3	4
Building and construction	35,000	45.4	8
Power, water and sanitation	7,300	59.9	2
Other services (Finance, distribution, transport, administration, etc.)	203,900	51.7	48
Manufacturing	159,300	75.8	38
Armed Services	100	-	-
Total Labour force	421,500	49.6	100
Total Population	1,172,000		

Sources: W. B. Sutch "Education for Industry", September, 1959 and Government Statistician. Above projection based on an assumed net inward migration of 10,000 persons per annum.

When analysing future industrial development in New Zealand two aspects appear significant. These are that the long-term population projections indicate a considerable increase in labour force available for manufacturing industry

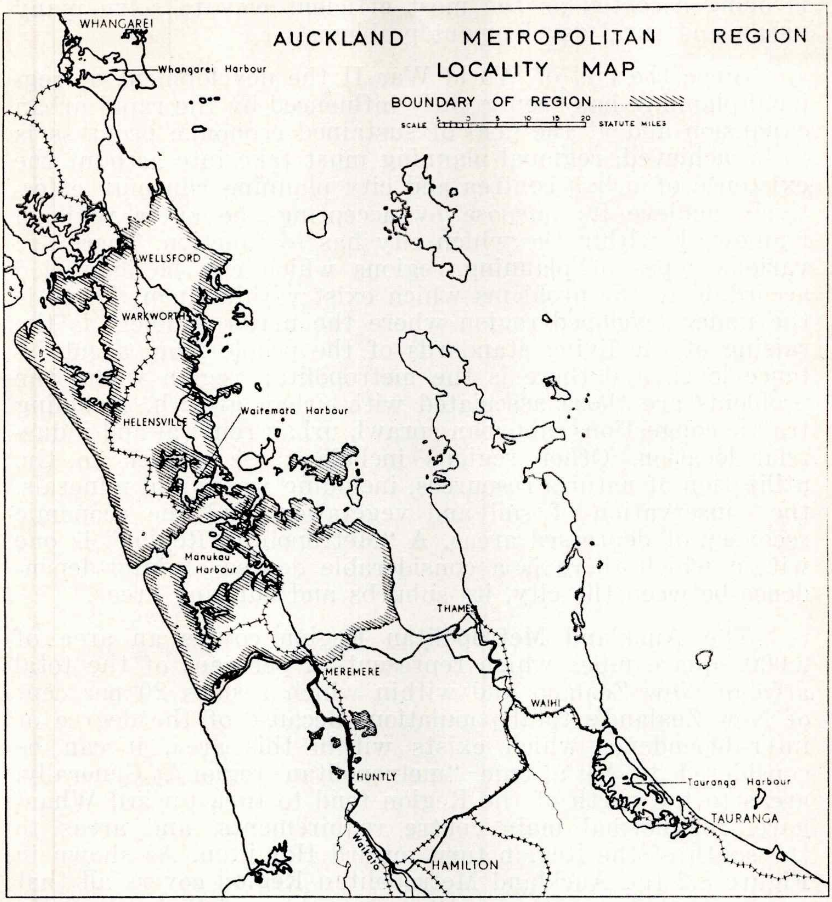

Fig. 8.2. Location map, Auckland Metropolitan Region.

and that the population is reaching the stage where, because of the increased potential market, a wider range of industries can become economic. The combination of these factors in conjunction with the overall economic situation should facilitate the development of manufacturing industries.

THE AUCKLAND METROPOLITAN REGION

Today the term "regional planning" is applied to a broad range of activities in many kinds of functional areas. Physically it is concerned with the problems of urban growth and with the problems of economic and resource development. We are now at a period when the validity of the regional concept and its practical application to planning is appreciated and

is being accepted as the most efficient way to solve many urban and rural development problems.

Since the end of World War II the development of regional planning has been greatly influenced by the rapid urban expansion and, if the goal of sustained economic progress is to be achieved, regional planning must take into account the existence of urban centres and city planning can only effectively achieve its purpose by accepting the outer regional framework within the which city has to function. There are various types of planning regions which can be identified according to the problems which exist within them. There is the under-developed region where the major problem is the raising of the living standards of the people from a subsistence level, and there is the metropolitan region where the problems are those associated with urban growth, including traffic congestion, suburban sprawl, urban renewal and industrial location. Other regions include those related to the utilization of natural resources, including water and minerals, the conservation of soil and vegetation, and the economic recovery of depressed areas. A "Metropolitan Region" is one within which there is a considerable degree of inter-dependence between the city, its suburbs and outlying areas.

The Auckland Metropolitan Region covers an area of 2,000 square miles which represents 2 per cent of the total area of New Zealand and within which resides 20 per cent of New Zealand's total population. Because of the degree of inter-dependence which exists within this area, it can be considered to be a true "metropolitan region". Generally, areas to the north of the Region tend to turn toward Whangarei for normal main centre requirements, and areas to the south of the Region turn toward Hamilton. As shown in Figure 8.2 the Auckland Metropolitan Region covers all that area lying between the northern boundary of Rodney county and the southern boundary of Franklin County. It is also gazetted as the Auckland Planning Region. All the constituent local authorities within this area are members of the Auckland Regional Planning Authority which is responsible for overall planning within this Metropolitan Region. The Region was defined by the Minister of Works in 1957 and comprises the Auckland Metropolitan Area (about 10 per cent of the total Region in area) and the land falling generally within the immediate sphere of influence of the metropolitan centre. There is no statutorily defined Auckland Metropolitan Area - although the term is in general use - the nearest comparable area is the Auckland Urban Area, and for the purpose of this paper Auckland Metropolitan Area and Auckland Urban Area are synonymous terms. The Auckland Urban Area is a statutorily defined area for census and statistical purposes

and the present boundaries of this area were defined in 1951. It is not an administrative or local government unit[1].

Table 8.6 is a summary of the area, population and capital valuation of the territorial local authorities within the Auckland Metropolitan Region. The area covered by each of these authorities is shown in Figure 8.3.

The population of the Auckland Metropolitan Region has increased from approximately 50,000 in 1890 to almost 500,000 in 1960, and during the 50 year period 1906-56 the percentage increase of population within the Region was more than double the percentage increase of population within New Zealand as shown in Table 8.5.

TABLE 8.5

NEW ZEALAND AND AUCKLAND METROPOLITAN REGION POPULATION

	N.Z.	Auckland Metropolitan Region
1906	936,000	115,000
1916	1,149,000	169,000
1926	1,408,000	234,000
1936	1,574,000	264,000
1945	1,702,000	329,000
1951	1,939,000	387,000
1956	2,174,000	428,000
% Increase (1906-56)	132%	272%

Figure 8.4 illustrates past trends in population growth in New Zealand, the Auckland province and the Auckland Met-

1. The following statistics provide some picture of the relationship of the Metropolitan Area to the Metropolitan Region. The total area within the Region is 1,287,000 acres, or approximately 2,000 square miles. This is made up of:

Auckland Metropolitan Area	—	approximately	113,000 acres
Secondary urban centres	—	,,	11,000 acres
Rural etc.	—	,,	1,163,000 acres
		Total:	1,287,000 acres

The total population - as at April 1960 - within the Region approaches 500,000 persons distributed broadly as follows:

Auckland Metropolitan Area	—	422,900
Secondary urban centres	—	13,000
Rural etc.	—	50,700
	Total:	486,600

The total capital valuation of the Region in 1959 was approximately £599,000,000 of which £543,000,000 was classified as "rateable":

Auckland Metropolitan Area	—	£464,000,000
Remainder of Region	—	£79,000,000
	Total:	£543,000,000

Administration in the Region is the responsibility of 32 territorial local authorities (one City, 25 Borough, one Town and 4 County councils and one Road Board) and more than 35 "ad hoc" local authorities.

TABLE 8.6

AUCKLAND METROPOLITAN REGION
CONSTITUENT LOCAL AUTHORITIES

Local Authority	Area (Acres)	Population (Est. 1-4-60)	Cap. Valuation (Rateable 1-4-60)	Pop. and Val. Mean %
1 Rodney County	305,273	7,070	£10,304,025	1.6
2 Warkworth Town District	1,427	1,050	1,004,040	0.2
3 Helensville Borough	1,315	1,190	1,046,875	0.2
4 Waitemata County	384,256	43,100	50,635,765	8.7
5 East Coast Bays Borough	3,850	8,440	9,793,945	1.7
6 Takapuna Borough	3,280	20,500	22,063,880	4.0
7 Devonport Borough	1,100	11,750	9,548,260	2.0
8 Northcote Borough	1,190	4,120	3,914,840	0.8
9 Birkenhead Borough	3,084	6,740	6,066,625	1.2
10 Henderson Borough	1,278	3,210	3,759,225	0.7
11 Glen Eden Borough	1,244	4,870	4,138,525	0.9
12 New Lynn Borough	1,393	8,510	7,567,335	1.5
13 Auckland City	18,493	141,900	213,051,310	32.6
14 Mt. Albert Borough	2,430	25,700	23,286,005	4.6
15 Mt. Roskill Borough	4,605	29,600	29,283,970	5.5
16 Mt. Eden Borough	1,476	18,650	18,033,480	3.4
17 Newmarket Borough	182	1,920	7,697,300	0.9
18 One Tree Hill Borough	2,430	13,150	15,198,355	2.6
19 Onehunga Borough	1,876	16,750	16,423,965	3.1
20 Ellerslie Borough	745	4,760	6,372,795	1.0
21 Mt. Wellington Borough	4,075	14,950	21,129,425	3.3
22 Howick Borough	1,534	5,810	6,147,805	1.1
23 Waiheke Road District	23,040	2,280	1,985,835	0.4
24 Otahuhu Borough	1,345	8,840	8,962,730	1.7
25 Papatoetoe Borough	2,241	15,800	15,219,730	2.9
26 Manukau County	152,333	24,100	32,017,675	5.1
27 Manurewa Borough	1,727	7,150	7,079,375	1.4
28 Papakura Borough	2,010	7,030	6,717,145	1.3
29 Franklin County	352,064	19,240	24,833,975	4.0
30 Pukekohe Borough	3,470	5,450	6,221,650	1.1
31 Tuakau Borough	1,091	1,420	1,170,300	0.2
32 Waiuku Borough	1,465	1,560	1,621,970	0.3
Total	1,287,322	486,610	£592,298,135	100.0

Sources: Areas from Lands & Survey Department; population from Government Statistician; valuations from Valuation Department.

ropolitan Area, and indicates projected population trends for these areas up to the year 2010. It is estimated that the Auckland Metropolitan Region is likely to reach 1,250,000 by the year 2000. Between 1926 and 1959 the percentage of the New Zealand population residing in the North Island and the Auckland Metropolitan Region increased from 63.4 per cent and 16.6 per cent to 69.2 per cent and 20.4 per cent respectively. It has been estimated that these proportions

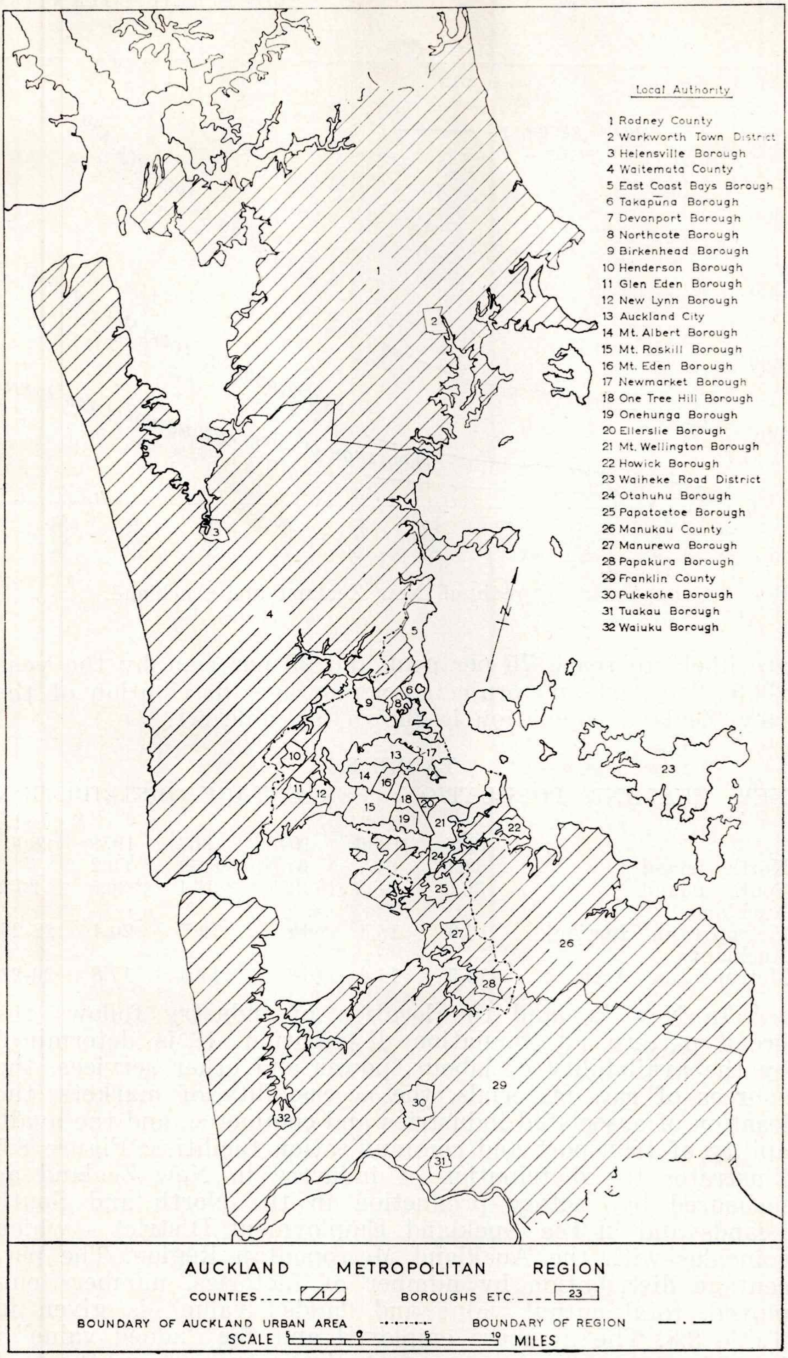

Fig. 8.3. Local authority areas within the Auckland Metropolitan Region.

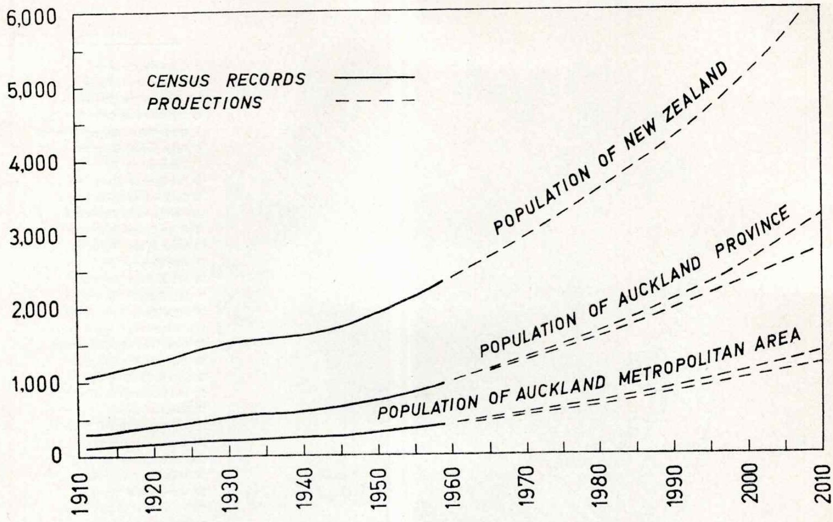

Fig. 8.4. Population growth of New Zealand and Auckland.

are likely to reach 75 per cent and 25 per cent by the year 2000. The past and projected percentage distribution of the New Zealand population is shown in Table 8.7.

TABLE 8.7

NEW ZEALAND POPULATION: PERCENTAGE DISTRIBUTION

	1926	1936	1945	1956	1959	Est. 2000
North Island	63.4	64.7	67.3	68.9	69.2	75
South Island	36.6	35.3	32.7	31.1	30.8	25
Auckland Metropolitan Region	16.6	16.8	19.3	19.7	20.4	22-25
Auckland Metropolitan Area	14.5	14.4	16.9	17.5	17.8	20-22

In New Zealand the location of industry follows the broad pattern of population distribution. It is determined by the availability of labour, power and other services, the sources of raw materials, the accessibility of markets, the location of associated industries and commerce, and the availability of transport and communication facilities. Figure 8.5 illustrates the distribution of industry in New Zealand as measured by factory production in the North and South Islands and in the Auckland Employment District - which coincides with the Auckland Metropolitan Region. The percentage distribution by number of factories, numbers employed, total output value and "added value" is given in Table 8.8. The numbers employed and the "added value" - i.e. value added in the manufacturing process - are the best

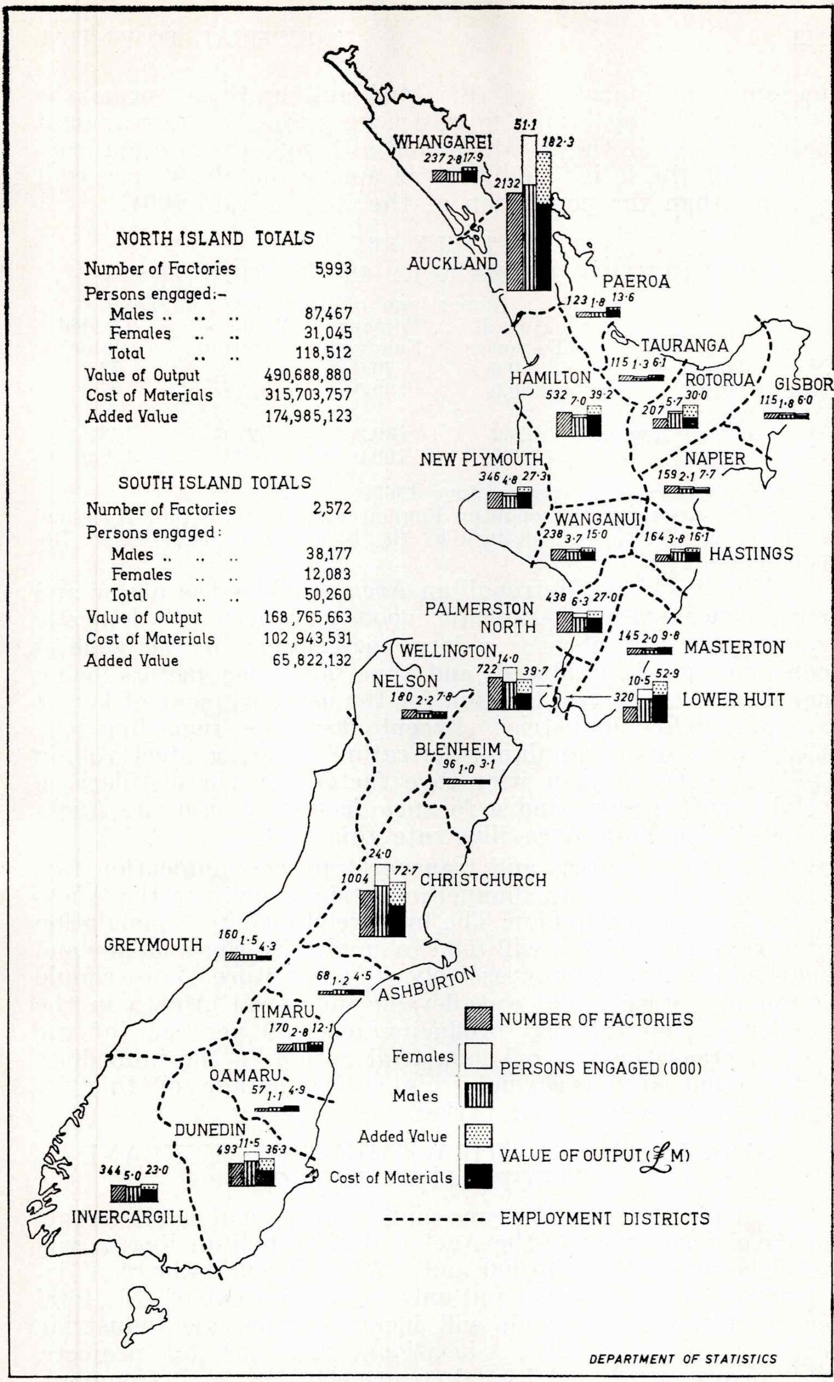

Fig 8.5. Distribution of factory production in New Zealand.

measures of industry of this kind and in these terms the Auckland Metropolitan Region accounts for the same amount as the whole of the South Island, although the present population of the latter (728,000) is approximately 50 per cent greater than the population of the Region (487,000).

TABLE 8.8

DISTRIBUTION OF FACTORY PRODUCTION 1958-59

	Percentage of New Zealand Total			
	No. of Factories	Persons Engaged	Value of Output	"Added Value"
North Island	70.0	70.0	74.4	72.7
South Island	30.0	30.0	25.6	27.3
Auckland Metropolitan Region	25.0	30.3	27.6	28.4
New Zealand	100.0	100.0	100.0	100.0

Source: Abstract of Statistics, June 1960.
Note: The Auckland Metropolitan Region coincides with the "Auckland Employment District" as defined by the Labour and Employment Department.

The Auckland Metropolitan Area provides the major and most concentrated market for goods produced for domestic consumption; it absorbs a large percentage of the general consumer goods produced. and thus, all other factors being equal, it is the logical location for the establishment of larger manufacturing industries. Recent decisions regarding the location of an aluminium fabricating plant, a steel rolling mill, a copper mill, a wire rope factory, a gin distillery, a soluble coffee plant and a formica factory within the Auckland Metropolitan Area illustrate this fact.

Labour resources and transport and communication facilities will also tend to channel industrial growth to the Auckland Metropolitan Region. The inter-relationship of population and industrial growth will tend to emphasize these labour and market conditions progressively in the future. This should result in a steady and considerable industrial growth in the Region in the future - producing over 30 per cent of the total increase in national industrial output in the immediate future and an increasingly higher percentage of this increase in the longer term period.

INDUSTRIAL GROWTH WITHIN THE AUCKLAND METROPOLITAN REGION

During the next 10 years capital investment in all aspects of development within the Auckland Metropolitan Region will total between £400,000,000 and £500,000,000. Industrial development can be considered only in the context of this total economic activity, which will include large-scale industrial, commercial, residential, educational and hospital projects, the provision of additional transportation and communication networks, and the extension of drainage and water

supply facilities. Main sewer drainage as provided in schemes under construction by the North Shore and Auckland Metropolitan Drainage Boards will serve, when completed, the whole of the existing main urban area and additional fringe areas. Those two major drainage schemes will serve areas sufficient to accommodate between them a population in excess of 1,000,000. Main water supplies from the Waitakere and Hunua catchments of the Auckland City Council are designed and are being developed within the same basic framework as the main sewer drainage schemes. The urban motorway system forming part of the Master Transportation Plan for Auckland is now in the first stages of construction. This system will provide arterial motorway roads which will serve generally the same areas as are to be serviced by the main drainage and water schemes. Port development by the expansion of the existing ports and the future provision of port facilities in the Upper Waitemata at Te Atatu - Rosebank will be within the confines of the existing urban area, and an additional airport which will serve Auckland for overseas and internal airline services will be constructed at Mangere.

Other aspects - the future population and its land requirements, the suitability of available land for various purposes, and the need for amenities and services - when considered in relation to the desirable direction and form of urban growth and expansion, provided the remaining "fixing points" for any comprehensive regional development plan. A generalized Outline Development Plan for the Metropolitan Region is shown in Figure 8.6. and the present extent of urban development within the Metropolitan Area together with major development proposals and zoning provisions is illustrated in Figure 8.7.

Auckland, as the largest metropolitan area and manufacturing centre in New Zealand, will continue to grow and expand. Geographically, it is a terminal for international air and sea routes, and it is a focal point of national and regional road, rail and air routes. Topographically, it has ample suitable and desirable building land. Climatically, it is equitable and generally attractive. Water supply resources are adequate and assured. Power and other services are as readily available, generally speaking, as in any other district. There are more than 1,000,000 acres within the Region which will remain as rural land irrespective of the amount or form of urban development and most of this land is of high actual or potential productive value. This will be able to supply all the market garden produce and daily milk supply requirements for the future population within the region.

In 1960 the population within the Auckland Metropolitan Region was approximately 490,000, and of this total approx-

imately 425,000 resided within the Auckland Metropolitan Area, 15,000 in urban centres outside the main urban area, and 50,000 in the rural areas of the Region. It is estimated that by the year 2000 the population of the Region will exceed 1,200,000 and the population of the Metropolitan Area will be more than 1,000,000. Implicit in this growth are very considerable planning resources. Buildings are going to be erected to house hundreds of thousands of people, to accommodate thousands of new industries, and to provide for expansion of all commercial services. Highways and streets will be provided and drainage and other services will be reticulated.

The North Shore drainage scheme will serve an area up to and including Albany beyond which the topography provides a natural line upon which to terminate a major block of urban development. It is desirable that expansion of the Metropolitan Area should be encouraged on the North Shore where the potential productivity of rural land is much lower than it is in areas to the south and west of the existing urban area. This North Shore area is very suitable for urban development and is sufficient to accommodate a population of approximately 200,000 people. The Auckland Metropolitan Drainage Board scheme is based on providing main drainage to an area beyond the limits of the present urban development to the east, west and south of the existing urban area. The urban motorway system will serve generally the same areas as are to be served by the two main drainage schemes. These services and facilities will cover the main urban area which will accommodate from 800,000 to 900,000 people.

With additional urban development in a proposed secondary area in the Manurewa-Takanini-Papakura area, provision will be made for an urban population in excess of 1,000,000 people, within an area of approximately 110,000 acres. This area, although sufficient when fully developed for the estimated population at the turn of the century, will not be sufficient for development purposes within this period. There is always the need for additional and quite extensive areas in the transitional stages - a certain amount of "slack" is always required in urban development areas because of land being subdivided, prepared for subdivision, being serviced and being held. A further urban area in the form of a true satellite development - in the Pukekohe-Buckland-Tuakau district will provide for further urban expansion during this period. There will also be a subsidiary urban area in the Silverdale-Whangaparaoa-Orewa district, and urban development in other parts of the Region based on the existing centres of Wellsford, Warkworth, Helensville, Waiuku and Mercer.

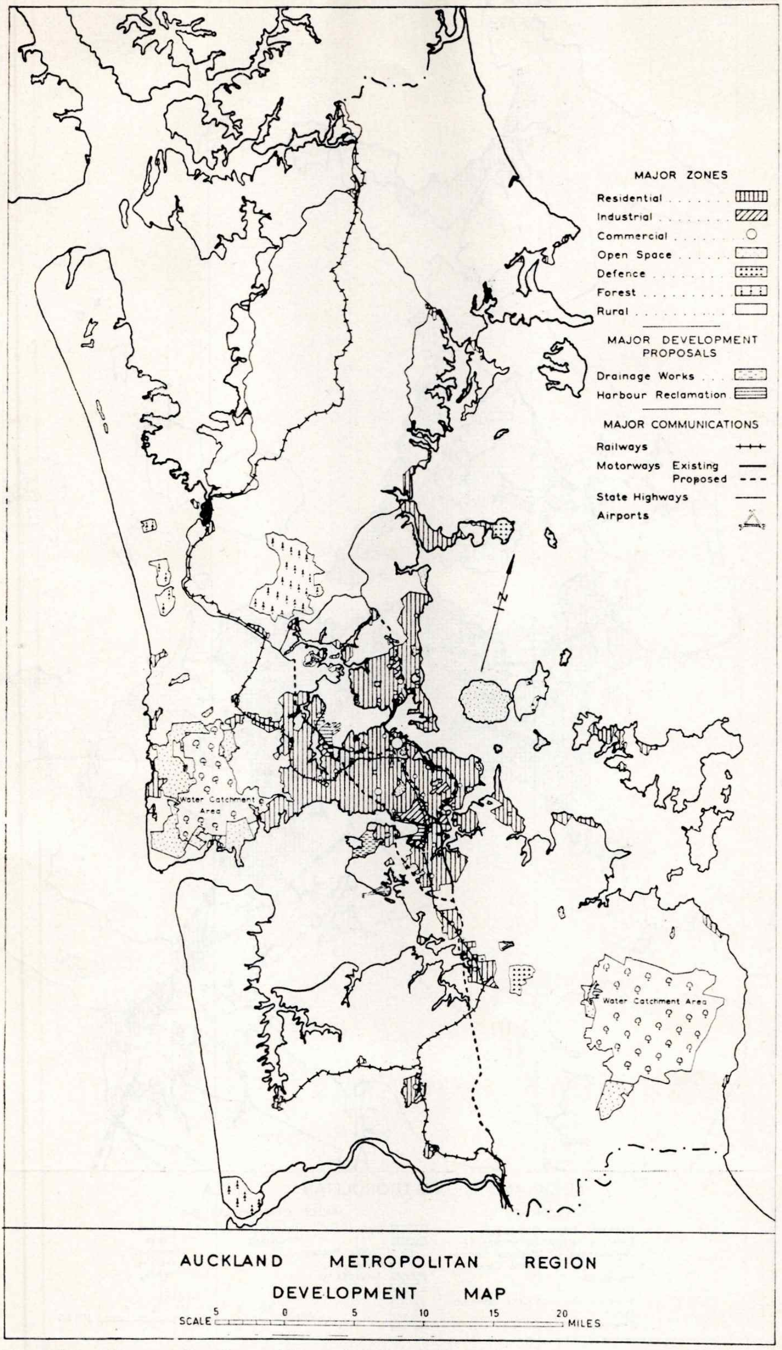

Fig. 8.6. Generalized outline development plan.

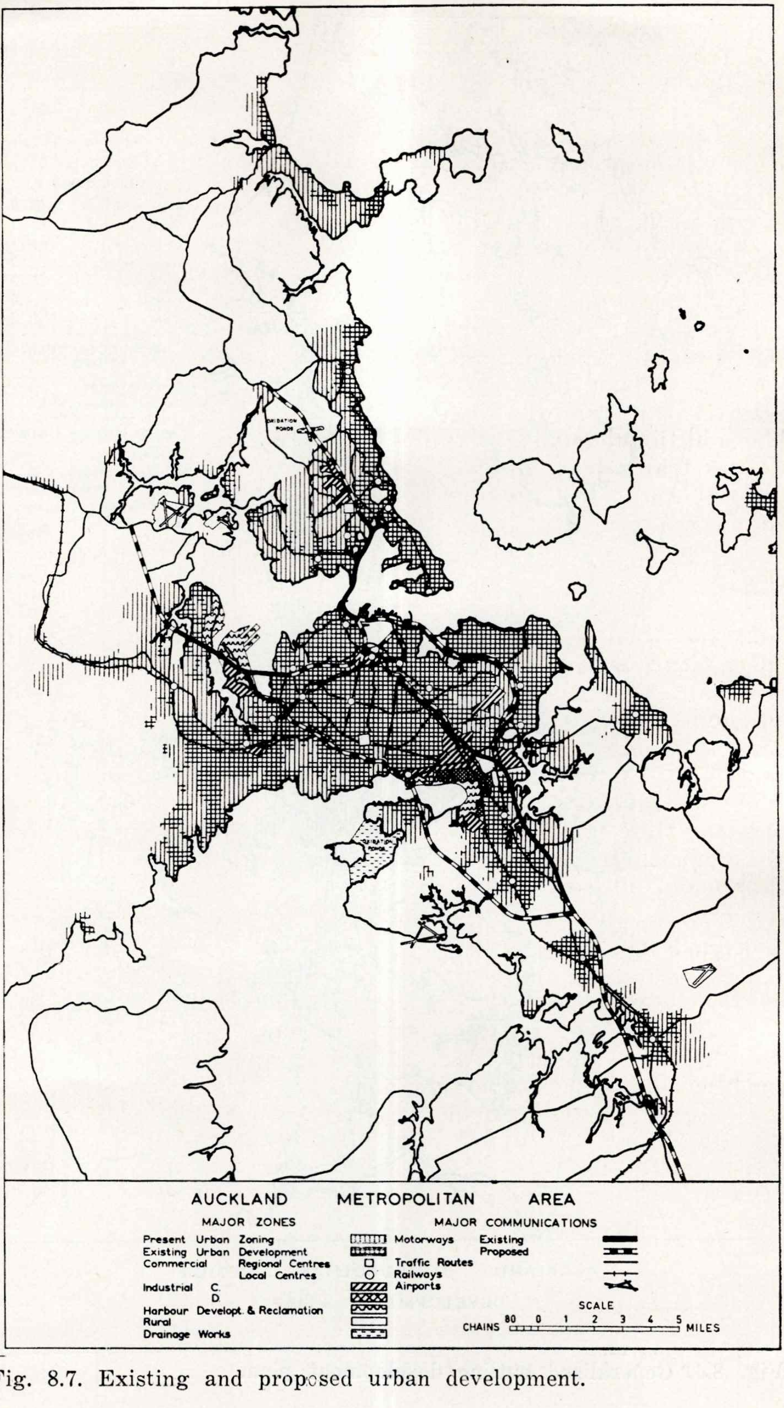

Fig. 8.7. Existing and proposed urban development.

The direction and form of urban development within the Region envisaged by the Auckland Regional Planning Authority may be referred to as the "cluster" form of metropolitan growth, which would result in the creation of an orderly, coherent and decentralized Metropolitan Region, comprising a main urban area surrounded ultimately by a cluster of communities with the main area itself taking the form of a cluster of units as development and redevelopment take place. Each of these inner units and outer communities would have - to varying degrees - their own decentralized functions, but would rely on the metropolitan core for regional functions and services. Auckland has reached the stage where it must tend to attract development simply by reason of its size. This is the "snowballing" effect of metropolitan growth. The additional mobility resulting from improvements in road and air transport will make the main centre increasingly more accessible and will provide the labour resources and potential markets for future industrial expansion.

Dr G. J. R. Linge, in his dissertation "The Geography of Manufacturing of Auckland"[2] dealt in detail with the history, growth and character of manufacturing industries in Auckland and with the factors influencing the distribution of industry throughout New Zealand. He also dealt with transportation, markets, labour and other factors affecting the location of industries within the Metropolitan Area. As this very thorough analysis of manufacturing in Auckland is shortly to be published, no reference has been made in this paper to the history and little to the geography of manufacturing within the Auckland Metropolitan Region. The paper has dealt in more general terms with industrial growth and expansion, both in New Zealand and in the Region.

The major industrial areas within the Region are shown in Figure 8.8 and are located on the North Shore at Chelsea (sugar refining), and at Devonport (naval dockyards); in the western area, at New Lynn (brick, pipe, ceramic, paper, timber, clothing, leather and glass products), Glen Eden (clothing, timber products) and at Henderson (wine processing, clothing, general engineering); in the southern area at Papakura (general engineering, formica and concrete products) and at Otahuhu (leather products, fertilizer works, railway workshops). There are no major industries in the eastern area, which is that part of Metropolitan Auckland lying between Mt. Wellington and Howick.

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2. Unpublished Ph.D. Thesis, University of New Zealand, 1959. See also G. J. R. Linge, The Location of Manufacturing in New Zealand, "N.Z. Geographer", Vol. 13, No. 1, April 1957, pp.1-18, and Manufacturing in Auckland: Origins and Growth 1840 -1936, "N.Z. Geographer," Vol. 14, No. 1, April 1958, pp.47-64.

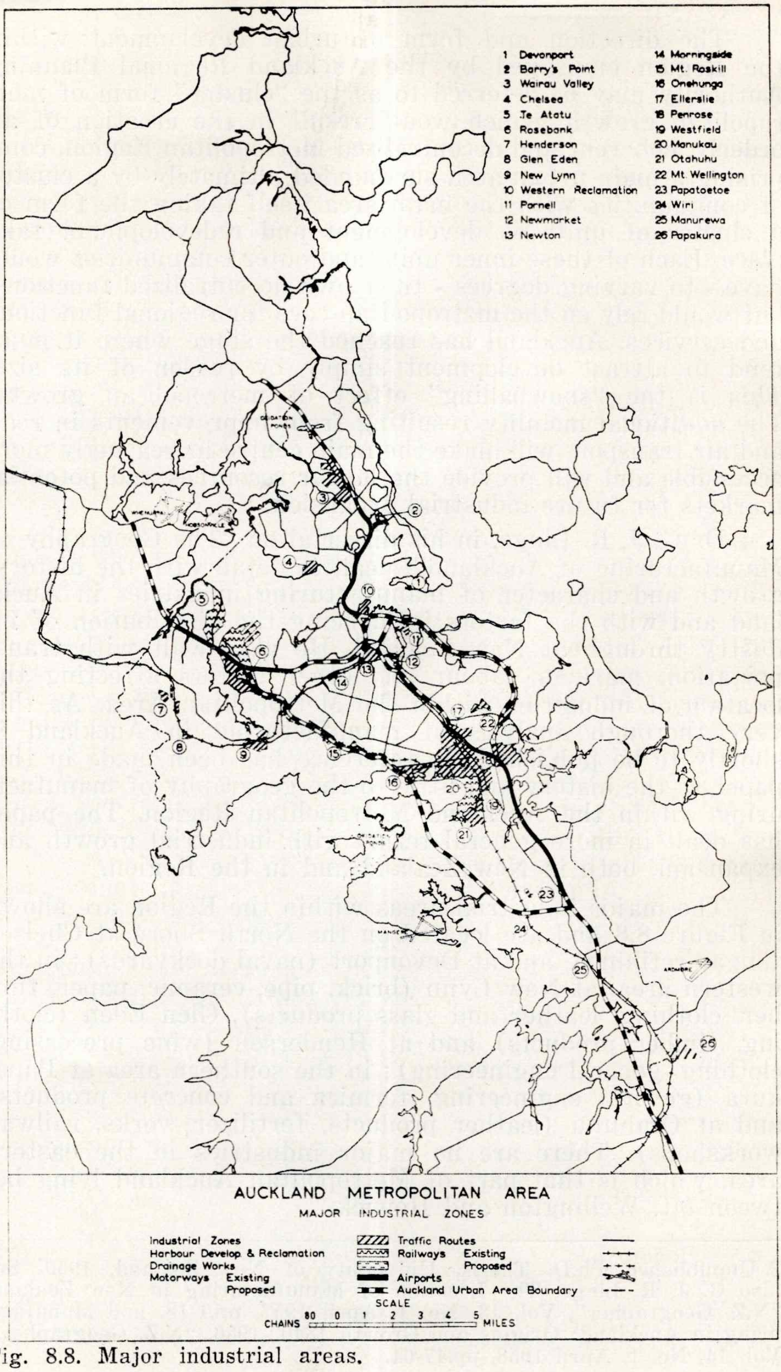

Fig. 8.8. Major industrial areas.

On the isthmus the major industrial areas are at Westfield (meat, chemical and soap works); Penrose (timber milling, general engineering, glass, plastic, rubber, paper, cement and bitumen products); Mt. Wellington (general engineering, assembly plants, quarrying); Onehunga (woollen and leather goods); Mt. Roskill (food processing, clothing, light manufacturing); Morningside (timber working, general engineering, light manufacturing); Mt. Eden (timber working, general engineering products, warehousing); Newmarket (beverages, food processing, timber working, vehicle maintenance and assembly); Western Reclamation (petroleum products, ship building, boiler making, general engineering), and within the Central Area (clothing, footwear, printing, food processing, general engineering).

The distribution of employees in manufacturing industries in the Auckland Metropolitan Area in 1956 is shown in Figure 8.9. In 1959 the factories within the Region numbered 2,132, employed 51,100 persons, and had a total value of output of £182,300,000. These factories ranged in size from one-man workshops to plants employing more than 500 persons[3].

Major extractive industries are located at Mt. Wellington and Drury (stone), New Lynn (clay), Miranda (shingle) and Mercer (sand). Dairy factories within the Region include the East Tamaki factory at Manurewa, producing butter, cheese, casein, dried milk and condensed milk; the Albertlands factory at Wellsford, producing butter and dried milk; the Lactos factory at Manurewa producing dried and condensed milk; and the Nestles factory in the City, producing condensed milk. In addition to the above, butter factories are located at Helensville, Paerata, Tuakau and Waiuku; cheese factories at Aka Aka, Otaua and Drury; casein factories at Paerata and Penrose, and milk treatment plants at Epsom and Penrose.

The grouping of industries is dependent upon numerous factors including the inter-relationship between different

3. Major industries at present located within the Region include: at Birkenhead, Colonial Sugar refinery; at New Lynn, Amalgamated Brick and Pipe Co. factories; at Pukekohe, New Zealand Packing Corp. canning factory; at Westfield, Auckland Farmers, Westfield and Southdown Freezing Co. works, Kempthorne Prosser chemical factory, Municipal Abattoirs; at Mt. Wellington, Fisher and Paykel assembly plant, Alec Harvey engineering factory, B.A.L.M. paint factory, Mason Bros. engineering plant; at Penrose, N.Z. Forest Products, Fletcher Timber Co., N.Z. Industrial Gases, N.Z. Glass Co; at Ellerslie, Bushells tea factory, Reidrubber factory, International Harvester plant; at Otahuhu, N.Z. Railway workshops; Challenge fertilizer works; at Onehunga, Onehunga Woollen Mills; at Mt. Roskill, Aulsebrooks biscuit factory, Holeproof hosiery and garment factory; at Mt. Eden, Henderson and Pollard timber factory; in the central city area, Northern Roller Mills plant, Fletcher Steel Co. plant; at Papakura, Formica plant, Hume cement factory.

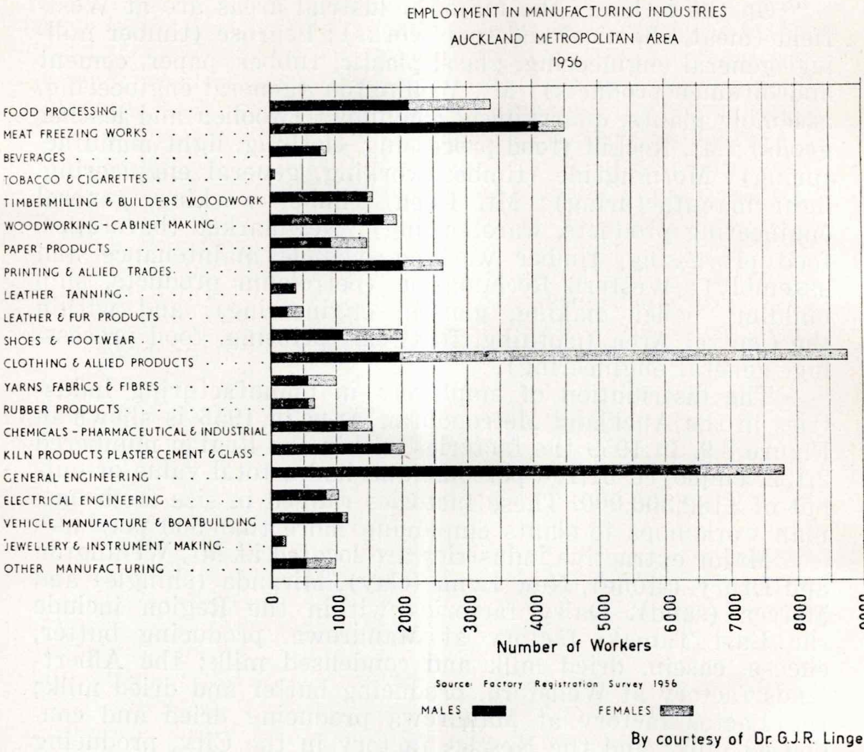

Fig. 8.9. Number of workers in various groups of industries.

types of industry. Industrial linkages occur within the Region and the best example of these is on the Mt. Wellington highway where the assembly plant of Fisher & Paykel Ltd. uses foundry products from Mason and Porter Ltd. whose factory is on an adjoining site, and sheet metal pressings from Alec Harvey and Sons Ltd., whose factory is on the opposite side of the road. The largest of the industrial complexes which occur throughout the Metropolitan Area, where firms use by-products of other industries in the same locality, is the Westfield - Onehunga complex, based on by-products of three large freezing works which are situated within a noxious industrial zone of approximately 500 acres.

Penrose is perhaps the largest and most intensively developed manufacturing area in New Zealand and Mt. Wellington is probably the most rapidly developing industrial borough. During the last five months, 57 permits for new factories were issued by this local authority, and although the borough already has extensive areas of industry, the amount of land available for future expansion is considerable

as the total area zoned for industry is in excess of 850 acres.

Major industries now being established in Mt. Wellington and in other parts of the Auckland Metropolitan Region include the Pacific Steel merchant bar mill at Otahuhu (£3,600.000), the Northern Aluminium rolling mill at Wiri (£2,000,000), the I.C.I. copper mill (£2,000,000), the Distillers gin distillery at Newmarket (£750,000), the British Paints factory at Rosebank (£500,000), the Nestles instant coffee factory at Papatoetoe (£350,000), the Formica factory at Papakura, the Nicholas Products pharmaceutical plant at Rosebank, and the Cookes wire rope factory at Mt. Wellington. The steel, aluminium and copper mills will each employ approximately 250 people, and together these industries will save more than £2,000,000 a year in overseas exchange.

In addition to the establishment of these major industries within the Region, large scale expansion of existing plants is planned by several firms including R. & W. Hellaby, N.Z. Forest Products, Fletcher Holdings and the N.Z. Glass Co. Appendix 8.1 (see page 191) lists the major manufacturing projects (new plants or expansion of existing plants) started or planned within the Region between January 1958 and June 1960. These projects involve a total capital expenditure of approximately £30,000,000.

Industrial growth within the Region is also reflected in the type and amount of other capital works now being undertaken or planned. Improved transportation networks and facilities, increased water and electric power supplies, additional commercial, residential, hospital, education and recreation facilities, are all associated with the present rapid rate of industrial expansion within the Region.

The value of projects - other than industrial - at present under construction or planned within the Auckland Metropolitan Region is very considerable. Within the central area of Auckland the value of major commercial projects now in progress or planned totals more than £11,000,000, and includes the Chevron-Hilton hotel of 23 stories (£3,000,000), the Kerridge-Odeon office building of 23 stories (£1,500,000), the Auckland City Council administrative building of 20 stories (£1 250,000), the Auckland Savings Bank of 24 stories (£1,000,000), the A.M.P. Society Building (£600,000), and the Norwich Insurance Building (£500,000). Other buildings to be completed in the near future include the N.A.C. air terminal the Automatic Telephone Exchange, the Auckland Transport Board offices, a new central police station and a public library. In addition to these projects the redevelopment of the Victoria Arcade will probably take place within the next decade. Recently completed structures within the Metropolitan Area

include the Auckland Harbour Bridge (£5,000,000), the Bledisloe State Building (£1,000,000), the Ellerslie grandstand (£500,000), the New Zealand Herald building (£400,000), and the Eden Park Grandstand (£200,000). Capital expenditure on new houses and flats within the Auckland Metropolitan Region (now being erected at the rate of more than 5,000 units per year) totals more than £15,000,000 per annum.

The provision of services and facilities to meet these increased demands from industrial, commercial and residential expansion also involves a large expenditure of capital. The estimated cost of urban motorways is at least £20,000.000, the final cost of Mangere International Airport will be in excess of £7,000,000, the Freyberg Wharf will be completed at a cost of more than £1,000,000, and the total cost of the Auckland Metropolitan and North Shore Drainage Board schemes will be approximately £17,000,000 - and this will not include the cost of reticulation by local authorities. The increased number and use of motor vehicles necessitates expenditure on the provision of offstreet parking facilities, and car parking buildings recently completed, under construction, or approved by local authorities will cost more than £1,250,000. The cost of reclaiming 800 acres of the Manukau Harbour for industrial purposes has been estimated at £5,000,000.

Expenditure on hospital and educational facilities during the next decade will also be very considerable, and the estimated expenditure by the Auckland Hospital Board on works in progress, in the planning stage, and provisionally approved, totals almost £14,000,000. The programme of the Education Board and Education Department for school buildings during 1958-60 totalled more than £2,500,000, and the cost of the new Seddon Memorial Technical College building will be approximately £500,000. Expenditure by religious bodies on churches and other buildings has also risen in recent years, and major proposals include the Methodist Church offices to be erected at a cost of £600,000, the Anglican Cathedral at a cost of £400,000 and the New Zealand Bible Training Institute at a cost of £250,000.

It has been estimated that in order to meet the requirements of the development which will take place during the next 10 years, supplies of water and electric power will have to be almost doubled, and the Auckland and Waitemata Electric Power Boards and the Auckland City Council are committed to heavy expenditure on large-scale expansion programmes. Reticulation of the additional water supplies, as well as sewer-drainage reticulation and the provision of improved roads and footpaths will involve many local authorities within the Region in considerable capital expenditure.

CONCLUSIONS

National labour force projections indicate that more than 150,000 additional employees will have to be absorbed by manufacturing in New Zealand during the next 20 years if full employment is to be maintained. More than 30 per cent of the total industrial employment is at present accounted for by industries within the Auckland Metropolitan Region. If present trends continue then 50,000 and possibly 60,000 persons will have to be absorbed into the industrial work force in the Region by 1980.

During the next 10 years the population of the Auckland Metropolitan Area will increase by more than the present population of Dunedin and 25,000 persons will have to be absorbed by manufacturing industries within this area. However, the present "explosive" rate of industrial expansion within the Auckland Metropolitan Region together with the rapid increase in commercial and residential expansion, the provision of related services and facilities including power, water supply and drainage, and the expansion of educational and hospital facilities is such that a large additional labour force will be required in the immediate short term future, and this may not be available without an increase in the immigration of skilled and semi-skilled workers and persons with technological and managerial training.

From the physical point of view primary implications are the amount and location of suitable land required for future industrial uses. Increased investment in plant per employee, automation, improved staff amenities, employee parking space and increasing attention to site treatment are all factors which increase the requirements for industrial land. Density, in terms of workers per acre, will vary considerably between different industries and will decrease with distance from the city centre. Generally three grades of industrial density must be considered in relation to location: intensive (within the inner urban area), intermediate (within the developed urban area but removed from the city centre), and extensive (on the outskirts of the urban area). In Auckland existing densities and conditions are changing rapidly and in some cases relatively large portions of sites held against probable future expansion give misleadingly low density figures. However, for planning purposes it appears that intermediate density standards of approximately 20 workers per acre and extensive density standards of approximately 10 workers per acre may be used.

Very little of the industrial labour force in the future will be absorbed in the inner or "intensive" industrial areas but some 20,000 are likely to be absorbed in approximately 1,000 acres of intermediate density available within existing industrial zones. On this basis and allowing for the remain-

ing industry at an average density of 10 workers per acre the industrial area requirements over and above existing zones within the main urban area would be: in the next 20 years (up to 1980) - 3,000 to 4,000 acres; and in the next 40 years (up to 2000) - 8,000 to 10,000 acres.

Provision for the dispersal of industry - as the major factor in future employment expansion - throughout the units within the Auckland Metropolitan Region is based on a balanced and diversified distribution. Heavy industry is related to main road and rail communications, and to essential port, water and drainage services. The location of such industries is generally determined by the above factors, and by the suitability of the substrata for heavy foundation requirements. General industry is not tied to particular localities by virtue of special needs and can be located to give balanced and diversified distribution of employment in relation to living areas, to reduce loads on transport and traffic facilities, and to promote stability in land and property values. Light and service industry is related to the localities served, and wherever possible is sited and designed so as to preserve the amenities not only of the neighbourhood but of the Metropolitan Area as a whole.

Areas which have recently been zoned for industrial use include the Wairau Valley on the North Shore, the Rosebank Peninsula and Carbine Road area on the isthmus, and the south-eastern area of Papakura Borough. Within Manukau County a special rural zone has been created at Wiri within which industry may be permitted with the consent of the County Council. Certain redevelopment areas have also been zoned for industrial purposes including parts of Freeman's Bay, Newton, Parnell, New Lynn and Onehunga.

With improved access via the Harbour Bridge and with the growth of population, industrial areas can be developed on the North Shore with advantage to the whole Metropolitan Area. The limited amount of heavy industry which will be located within the Auckland Metropolitan Region will be tied to areas directly served by rail and port facilities, but a considerable amount of general manufacturing and servicing industry could be located on the North Shore which has no rail or port facilities.* Therefore, provision has been made for a general industrial area as well as for local light or service industrial areas on the North Shore. The main industrial zone has been located in relation to transport routes serving the area, and it is situated in the Wairau Valley where a great part of the land is low and flat and unsuitable for residential development. The development plan for this major

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* With the exception of the private wharf at the Colonial Sugar Refining Company's works at Birkenhead.

industrial zone provides for landscaping and planting along the northern motorway, on the periphery of the zone, and within the zone. The general aim is to avoid an unbroken mass of industrial development when viewed from either the motorway or surrounding localities. The gross area zoned in this block totals between 450 and 500 acres and the net area available after allowing for roading and amenity reserves will be in excess of 350 acres which would be large enough to accommodate from 7 to 8 per cent of the total metropolitan requirements for general industry.

Strong economic and social forces will lead towards the future growth and expansion of the Auckland Metropolitan Region at the rates which have been forecast. Equally strong and continuous action by government in the national control of the location of population and industry would be required to counter these economic and social forces. The amount and rate of future development within the Metropolitan Region makes a strong case for firm control of the direction and form of urban growth within the Region based on long term and farsighted regional proposals, and for the the establishment of a regional authority with the powers to assist in the implementation of these proposals.

Throughout the world increasing population and industrialization are exerting pressure on limited land resources. This pressure will be felt in New Zealand during the longer term period, not only from the internal forces of development, but also from external forces - particularly in Southeast Asia. Therefore, it is in the national interest that a more rational approach is made to the use of our own resources and such an approach requires a national policy of development, providing for effective and efficient utilization of the country's resources. Such a policy can be formulated only within the framework of regional as well as national and local requirements. Planning and administration on a regional basis must become an integral part of our development process.

THE HUMAN FACTOR

A. Joan Metge, Ph.D., M.A.*

The preceding papers in this series have dealt with many aspects of New Zealand's natural resources and the means by which they are being developed. But except for brief references nothing has been said about the human factor in industrial development. Yet people must always be involved in industrial development. They are themselves one of the key resources of a country, providing the man-power, the skills, the organization and the business acumen without which raw materials must remain unexploited. But unlike other industrial materials, people are not inanimate objects which can be manipulated in the interests of higher production, without regard to their reactions. They have minds of their own, and how they think and feel, not only about the enterprise in which they are employed, but also about the general circumstances of their lives, has a vital bearing on their efficiency and productiveness. The wise industrialist takes this into account. Even more important, in a country that proclaims the ideals of democracy, the happiness of those involved in industry is, or should be, a goal itself, independent of its effect on production.

I do not propose to cover the whole question of the human factor in industry. I am not qualified to do so and space would not suffice. Instead I am going to touch on those aspects of the problem which have attracted my attention in the course of my work as an anthropologist during the last two years.

I should like first to give some consideration to the problem of people as an industrial resource. Modern industrial development depends not only on the number of workers available but also on the skills with which they are equipped. For purposes of the present discussion I am going to widen the definition of "skills" to include the qualifications of professional workers such as chemist, civil engineer or accountant, at one end of the scale, and those of trained machine

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* Dr Metge is a social anthropologist holding a Carnegie Social Science Research Fellowship. She is engaged in full-time research on modern Maori social organization.

operators at the other, as well as those associated with specialized trade training. (It will also be noted that I am using worker to refer to all employees instead of distinguishing between "staff" and "workers" as is common in industrial concerns.)

It is to the benefit of both the industry concerned and the workers as individuals that each person's aptitudes should be developed and his preferences consulted as fully as possible. Ways and means of making the best use of various natural resources are being vigorously pursued. But is the same attention being paid to making the best use of our human resources? I do not know enough about the scope of vocational guidance provided by school teachers and government departments, or the extent to which industrial concerns provide special facilities for training their workers or encouraging them to study, to attempt to answer this question. But I feel that it needs to be asked, and asked often.

In one paper in this series it has been suggested that the rate of immigration of skilled persons needs to be greatly accelerated if the needs of industrial development in New Zealand are to be supplied. It seems to me that immigration can and should be only part of the answer, though I would not question its importance. The real problem is to find those with the right aptitudes and make sure that they are trained and employed in the right jobs. Using our human resources to the best advantage - avoiding unnecessary waste of talent - is as important to industrial development as having the raw materials, the power, and the most efficient machinery and techniques.

Helping the individual worker to find his proper place in the industrial structure is complicated by social and cultural factors. as well as by personal problems. Since my own experience has been entirely with the Maori minority I propose to illustrate my argument by reference to that particular group. It is easier to identify these factors in the case of a small, well-defined, ethnic and cultural group such as the Maori; but it should be remembered that similar influences are at work in the population as a whole.

THE MAORI IN INDUSTRY

Even to the man in the street it is obvious that Maoris tend to gravitate to certain types of occupations. A fairly high proportion is still engaged in agriculture, forestry, hunting and fishing, though it has steadily decreased over the last 20 years. In 1956 this category accounted for 26.5 per cent of those actively engaged in industry, compared with 15.6 per cent of the non-Maori section of the population. Outside primary production, a higher proportion of Maoris

is found in unskilled and semi-skilled occupations; they are more interested in some trades (especially carpentry) than others; they are not well represented in commerce and services (18 per cent compared with 38 per cent of the non-Maori group); but they are more numerous (relatively speaking) in construction work than non-Maoris[1]. Maoris form an important section (30 per cent) of the work force employed in building the Waikato power projects, supplying approximately half the workers operating earthmoving and other heavy machines and about 25 per cent of the carpenters, but few welders or electricians[2].

What sort of influences affect Maori employment choices to create this situation? In the first place, there is the problem of the limited knowledge of the potential worker and his family concerning the range of jobs available. Maoris coming to an industrial town from the country are familiar only with the more common types of jobs, and they do not know to whom or where to go to find out what is offering. They usually take the first job offered them or seek one at a place where they have relatives working, regardless of its suitability for them personally. This is one reason why they often change jobs frequently in their first months in the city.

Secondly, under certain circumstances high wages are more important than a less well-paid job that is congenial. Maoris are attracted to labouring and semi-skilled jobs that offer plenty of overtime, even when they have good educational qualifications, because in most cases they have known what it is to go without enough money, because they desperately need the means to better their housing conditions or educate their children, or because they come from or have large families To Pakehas, the higher social status attaching to white-collar jobs and their future prospects compensate to a large extent for lower income, but status of this kind matters little to most Maoris, who derive their chief satisfaction from membership in the Maori group, where they are evaluated on other grounds, and where indeed high occupational status may set them too much apart from their fellows. Besides, most Maoris, used to an untrammelled country life, much prefer work that entails physical effort and as much time spent out-of-doors as possible.

Thirdly, a tendency to conservatism is a common human characteristic: people tend to stick to the familiar. Maoris strongly favour those kinds of occupations and those particular work situations in which friends or relatives or at least some other Maoris are employed. They are reluctant to be the first Maori to move into a new field, a new firm or a

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1. Maori Population and Dwellings, "N.Z. Population Census 1956", Vol. VIII, pp. 19-20.
2. Information supplied by Ministry of Works, Mangakino.

new work team. For in addition to the normal problems of adjusting to a new job and new workmates, they are faced with isolation during working hours from those of their own background, isolation among people of whose outlook and code of behaviour they are uncertain.

Fourthly, membership in a cultural minority can limit or direct the individual into certain employment as a result, on the one hand, of discrimination on the part of the employer, supervisor or workmates, and on the other hand, because of pressures from his own group to conform to their accepted patterns or risk rejection. The Maori community places great emphasis on the solidarity and loyalty of its members and also upon their obligations to be present and share the work at general gatherings of the group, particularly at "tangi" (funerals). Community members tend to criticize adversely the person whose job places him in a position of super-ordination in relation to other members or interferes with his duty as a Maori. Many able Maori workers refuse promotion or the opportunity for special training because it would not merely separate but also alienate them from their mates from the same community. However, this is more common in situations where workers are drawn from a local community of "tangata whenua" (people of the land) who have been associated with the district for generations. Such is the case with many who commute to work in Whakatane, Rotorua and Kawerau. But in those towns and cities where the majority of Maoris are immigrants of many different tribes, to whom many of the other Maoris they meet at work and socially are strangers, there is much more scope for individual achievement.

Fifthly, cultural values and traditions exert a strong influence in predisposing workers towards certain kinds of job. The Maoris, who place a high value on co-operativeness and sociability, prefer to work and work better, as part of a team. They also like rhythmic work and will cheerfully tackle fairly monotonous work provided it has this quality. Their traditional work pattern was one of long periods of heavy work alternating with considerable periods of inactivity. Today this kind of routine is still congenial: hence their affinity not only for seasonable jobs like shearing and harvesting but also for work in freezing works and wool stores. It is unwise, however, to assume that all members of a cultural group will follow the dominant pattern. There is always a range of individual variation within each group. I know Maoris who, in the face of the general Maori belief that "we are no good at handling money" run successful market gardens and manage the financial affairs of shearing gangs earning thousands of pounds in a season. Also, assumptions about group aptitudes can prove wrong when changing cir-

cumstances offer a new range of opportunities. Because their ancestors were horticulturalists, both Maori and Pakeha assumed for a long time that Maoris would be happiest as farmers. But in recent years it has become apparent that many Maoris became farmers as a means of remaining on their ancestral land, and not because they liked the life. Now that they are more aware of the opportunities in other parts of the country, and as alternatives become available within commuting distance of their homes, they are moving into other jobs. The capacity and liking they show for work as carpenters and machine operators would never have been deduced from their previous rural background.

Undoubtedly the jobs in which most Maoris are found today are congenial and make good use of their particular aptitudes and preferences. But it would be a pity if it became accepted that these were the most suitable jobs for Maoris and no attempt was made to test their capacity for others, either as a group or as individuals.

INDUSTRY AND PEOPLE

Whether it involves the expansion or revision of existing industries or the establishment of new ones, industrial development inevitably effects changes in people's lives. This statement is so obvious that it is usually completely overlooked. Whether it takes place in existing towns and cities or brings entirely new towns into being, industrial development has two inevitable results: it stimulates population movements and it increases the relative importance of the urban population. In New Zealand it has also meant an increase in the concentration of population in cities of over 20,000. However, largely within the last 10 years, a counter trend has become apparent with the establishment of industries connected with the development of power and forest resources in certain of the smaller regional centres close to the sources of raw materials (e.g. Whakatane and Rotorua), and in new towns built where there were none before (e.g. Mangakino, Meremere, Kawerau and Tokoroa in the North Island, and Roxburgh and a future town at Manapouri in the South Island).

Industrial development is also a potent factor in bringing about social and cultural changes, for it modifies the nature of our main cities, calls into being towns that differ radically from existing regional centres, and, in the North Island at least, brings together representatives of different cultural groups. European immigrants have always tended to congregate in the cities, and they are also attracted to the hydro and mill towns. Since the early war years the Maoris have begun to move from the country into the more industrialized towns and cities, significantly by-passing the rural servicing centres. A high proportion of both Maoris and

immigrants is now a feature of both the main cities and the new towns of the North Island.

The kinds of problems posed by the urbanization of former rural dwellers and the increasing industrialization of the big cities are familiar enough. I do not propose to explore them here. Instead, I would like to describe some aspects of two of the completely new towns created by recent industrial development. Mangakino, which is associated with the development of the power of the Waikato River, and Kawerau, the site of the largest pulp and paper mill in New Zealand, are new towns in more senses than one. Apart from the fact that neither is more than 15 years old they differ in many significant ways from other New Zealand towns of comparable size. Each presents to the people who go to live and work there a social and economic environment that is new and challenging. To the geographer, the sociologist and the social historian, they are a fascinating field laboratory.

MANGAKINO

Mangakino can still be fairly described as a Ministry of Works town[3]. First established to house workers on the Maraetai Dam, it lies on the southern shore of the Maraetai Lake, on land leased from Maoris belonging to the Ngati Kahungunu tribe. The township site is part of a block of 30,486 acres granted to certain Ngati Kahungunu "hapu" (sub-tribes) in compensation for the surrender of their rights in Lake Wairarapa. Some of the owners still live in the Wairarapa area, but some 30 families are farming land adjacent to the township (the Pouakani Maori Land Development Scheme) under the supervision of the Department of Maori Affairs. Apart from these families, Mangakino is isolated from other settlements by pine forests and undeveloped scrub lands - 25 miles from Tokoroa, 38 from Putaruru 47 from Taupo and 20 from the small forestry village of Pureora.

The first construction workers, all single men, arrived in Mangakino in 1945 but its real growth began when the first family houses were ready for occupation in 1947. The population jumped to 3,000 within two years, passed 4,000 in 1950 and 5,000 in 1955. In April this year (1960) Mangakino township (excluding the permanent villages at Maraetai and Whakamaru) had 5,588 inhabitants. Its population has now ceased to grow. After the middle of 1961 it is expected to drop sharply within the space of a few years as construction workers are withdrawn with the completion of the dams.

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3. The author wishes to acknowledge help received from the Project Engineer and Employment Officer, Ministry of Works, Mangakino, and the General Manager, Chairman and Secretary of the Mangakino Hydro Welfare Association and from members of the Maori Tribal Executive.

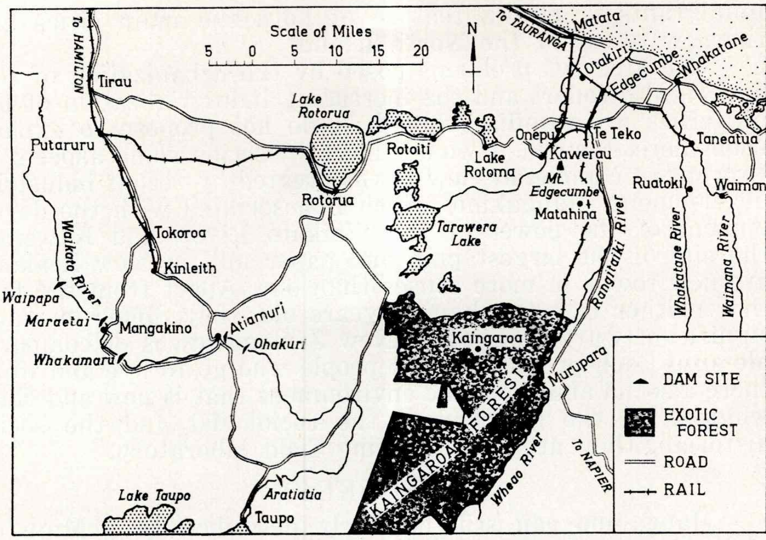

Fig. 9.1. Location of Mangakino and Kawerau. Private exotic forests not shown.

At present, 1,253 employees of the Ministry of Works live in Mangakino, comprising with their dependents four-fifths of the total population; but their number will have fallen to 400 in 1964. Mangakino will remain a town occupied by employees of the New Zealand Electricity Department and by those engaged in the usual activities of a country town. It will serve a large hinterland as more land is developed for farming, but unless other industries can be attracted, it will be less than one-quarter the size it was in its heyday.

The land itself still belongs to the Maori owners, the Ministry of Works having leased it for a period of 22 years to 1969 or the earlier completion of the power stations. After long negotiations, the owners (who formed themselves into an incorporated company in 1957) have agreed to take over the roading and underground services installed by the Ministry of Works, paying back the cost out of rental income. Most independent occupiers (e.g. shopkeepers, the Maori Tribal Executive) hold sub-leases from the Ministry of Works, but the latter has surrendered its interest in certain sections to enable those who wish to remain in the town (e.g. the churches and the proprietors of the hotel) to arrange direct leases with the owners.

From the beginning, the majority of Mangakino residents have known that there was a term set to their stay. This limitation of future prospects affects the town and its people in many ways. Only a little over one-quarter of the town's 1,094 houses (164 provided by the Ministry of Works for

members of its permanent staff and 96 owned by private individuals) are designed to outlast the construction period (15 years). The remaining 76 per cent are limited-life Ministry of Works houses, a few transferred from earlier schemes, but most are "Mangakino-type houses", built to a single plan, with an area of 530 square feet. Recreational facilities, however, are very good; they were moreover, acquired early in the town's history, thanks to the efforts of early settlers from other public works settlements who knew their value. The prospective drop in population, coupled with the difficulties of obtaining land title, has discouraged business firms from other towns from establishing themselves in Mangakino to the extent that the present population would warrant. Most of the inhabitants cannot put down roots in the town, even if they would. This fact is clearly reflected in a general lack of interest in gardening.

As it exists at present and has existed for the past 10 years, Mangakino is dominated by employment on the great power stations which are being built by the Ministry of Works along the Waikato River. Maraetai and Whakamaru were completed in 1952 and 1956 respectively, but workers still travel out from Mangakino each day to work at Atiamuri (which is already producing power), Waipapa, and Ohakuri, (which will come into production early in 1961), and to Maraetai No. 2 begun this year. (Another Ministry of Works settlement at Atiamuri houses men working at Atiamuri, Ohakuri and Aratiatia.) Of the approximately 1,700 adults who are gainfully employed in Mangakino at present (1960), 73 per cent (1,253 in April) are directly employed by the Ministry of Works, and another 4 per cent indirectly as independent contractors. The rest find work with the Electricity Department (6 per cent) and other government departments (5 per cent, including 55 school-teachers), and in service occupations and commerce (12 per cent). Mangakino has 19 shops, employing 133 persons.

Women's jobs are scarce; most of those in employment are either shop assistants or school-teachers. Only 14 are employed by the Ministry of Works, all in the office. Catering in the works camps is done on contract to the men and not by the Ministry of Works. The number of women gainfully employed in Mangakino does not exceed 140, or 8 per cent of the total labour force.

Teenage boys pose a similar problem, particularly those who leave school at fifteen. Construction work is heavy and often dangerous. The Ministry of Works will not accept anyone under 18 years old for training on earth-moving machines. Apprenticeships in the trades are not plentiful, partly because most of the tradesmen in the town are employed by the Ministry of Works on co-operative contract, which debars them by

law from training apprentices. Older boys with School Certificate or University Entrance qualifications are easier to place but they are less numerous and a higher proportion seek work or higher education elsewhere. The Ministry of Works takes between six and eight apprentices a year, three or four technical assistants and a couple of clerical cadets.

Construction work provides constantly changing temporary employment for a large number of workers. Many of the incentives usual in permanent business (superannuation, promotion, security) cannot be offered; compensations take the form of higher wages, plenty of overtime, and free but temporary accommodation. As a result, single men form a significant component of the labour force, 312 (25 per cent of those employed by the Ministry of Works) being accommodated in camps and hostels. The turnover of labour is fairly high, though at roughly 26 per cent per annum it is well within the margin considered satisfactory for construction projects. The Waikato projects offer longer periods of continuous employment than most public works schemes, and they have a higher proportion of married men. Labour turnover is as high as 40-50 per cent among the single men, but only 7 per cent for the married.

Although they are all engaged in a single enterprise, the workers employed by the Ministry of Works represent quite a wide range of occupations. Pay schedules list 145 different designations. About 19 per cent come under the heading of professional and clerical staff, which includes civil engineers, accountants, draughtsmen, technical officers and technicians, as well as office staff. Just over a quarter (26 per cent) are skilled workers, most of them qualified tradesmen: carpenters, riggers, welders and boilermakers, fitters and mechanics, plumbers, electricians and painters. Another 2 per cent are apprentices in certain of these trades. Semi-skilled workers account for 21 per cent, and 32 per cent are labourers and handymen. Most of the semi-skilled workers are plant operators, a generic term that covers drivers of tractors and bulldozers, crawler-tank shovels, euclids, winches and cranes, heavy transporters, road-graders and fuel-tank waggons, waggon-drill and cableway operators, and bore-drillers. The Ministry of Works also employs a considerable number of timber workers, having established a mill of its own to handle pine trees cleared in the course of development. This mill produced the timber for the houses in the town and until recently all the boxing for construction purposes.

In order to attract the necessary labour and services, particularly in view of the town's isolation and the limited duration of the projects, the Ministry of Works offers free housing and high wages. The Ministry provides 672 temporary

and 200 permanent houses for its employees, the former rent-free, and rents another 126 (mostly "prefabs") to other residents. The distribution of income among Ministry of Works employees during 1959 is shown in Table 9.1.

TABLE 9.1.

PERCENTAGE OF WORK FORCE IN VARIOUS INCOME GROUPS.

	Under £900	£9-1100	£11-1300	£13-1500	Over £1500
Staff	14	25	34	25	2
Workers	11	35	43	11	—

This shows that well over half of the employees were earning more than £1,100 a year. The amount of overtime available has fallen compared with the early years, but bonuses are ample and nearly 70 per cent of the tradesmen are employed on co-operative contracts. Under this scheme, good workers can earn as much as one-third more than on wages. The Ministry of Works also offers good opportunities for promotion, since it is its policy to draw all senior non-professional workers (foremen, overseers, construction superintendents and inspectors of works) from those on the job.

The importance of work on the power schemes lends a particular unity of purpose, a singlemindedness, to Mangakino. The whole town is caught up, directly and indirectly, in a single enterprise in a way that is foreign to the average New Zealand town. Physical isolation from more normal, diversified communities heightens this preoccupation with one central interest. Mangakino residents recognize and laugh about the way in which the construction of the dams dominates their lives and conversation; they say that "it either gets you or you get out". But in a rueful way, they are pleased that Mangakino is not like other places. Even the ordinary labourer is well informed on progress and can quote figures about the size of the dams and their lakes, the amount of concrete that has been poured, and so on. Not only the workers but the townsfolk as a whole are stirred to a possessive pride in the Waikato dams and of their own part in their construction. And this, one feels, is something that will stay with them when they have moved on.

Mangakino is highly distinctive in several other ways, most of them again related to its character as a single industry town. For instance, the population of the town is an exceptionally young one. Forty-seven per cent are under 15 years of age (compared with 31 per cent for New Zealand as a whole), a very small proportion are over 50 and retired people are conspicuous by their absence. The birth rate is one of the highest in the country, the death rate comparatively low. There are more men than women in the town, because of the number of single men housed in Ministry of Works camps

and hostels. The male-female ratio is 100:85 for the population as a whole. Amongst the adults it is 100:73.

Mangakino is also characterized by heterogeneity of its population. Of those employed by the Ministry of Works, 30 per cent are Maoris, 20 per cent are immigrants from overseas, and 50 per cent New Zealand-born Pakehas. Maoris make up approximately the same proportion of the total population, but the proportion of immigrants is probably lower, because of the number who have married New Zealanders. Even so, Mangakino undoubtedly has a higher proportion of both Maoris and immigrants than any other town in New Zealand. As recently as the last census in 1956, the highest proportion of Maoris in any other town was 15 per cent in Rotorua; the only other town with more than 10 per cent was Whakatane. The Maoris are drawn from almost every tribe in New Zealand, the largest groups being Waikato-Maniapoto, Ngati Porou and Ngapuhi, in that order. The immigrants are mainly from the United Kingdom, but there are considerable numbers of Dutch, some 40 Islanders (mainly Samoans) and their families, and a sprinkling of other nationalities.

The Maoris, feeling the need for a meeting-place on traditional lines, early banded together to form a Tribal Committee under the terms of the 1945 Maori Social and Economic Advancement Act. This committee, which could be more accurately described as a multi-tribal committee, secured the sublease of a "marae" area from the Ministry of Works, raised the money and built a hall with voluntary labour. At the same time several tribal groups established sporting and welfare clubs, the latter a form of savings association designed to help members with money and in other ways in times of sickness and death. Earlier this year, on the advice of the Department of Maori Affairs, the Mangakino Tribal Committee amalgamated with the Pouakani Tribal Committee as the Pouakani-Mangakino Tribal Executive, thus linking the multi-tribal community in the town with the local farming community. As in other towns and cities, the Mangakino Maoris have had to learn to live not only with members of other ethnic and cultural groups, but with members of other Maori tribes.

One of the most remarkable features of Mangakino, especially in view of its short history, is its excellent community facilities. It has a cinema theatre seating 600, three other halls (a gymnasium which accommodates an indoor basketball or three badminton courts and can be converted into a theatre seating 700, a social hall seating 250, and a Youth Club Hall), a 6,000 volume library, a billiard saloon, a Scout Hall, a boxing gymnasium, a hobby club hut, numerous committee rooms, and a fire station. All these buildings together form a Civic Centre

adjoining the shopping centre in the heart of town. There are also four football fields, two bowling greens and six sets of tennis courts.

The Civic Centre is administered by the Mangakino Hydro Welfare Association, an organization which must be practically without parallel in New Zealand. Inspired and nursed in its early days by workers who came to Mangakino from Karapiro, the Welfare Association was formed at a public meeting and registered as an incorporated body in 1947, very early in the town's history. It comprises delegates from 66 affiliated bodies — sporting, religious, educational, welfare and recreational organizations. The governing body is the Executive, which consists of 10 members elected by the Mangakino delegates from their own number and three representatives from Atiamuri. It employs a general manager, 11 permanent members of staff and 7 part-time workers. The affiliated bodies pay no fees: the association finances its activities out of income from the cinema theatre. (The billiard saloon is run by a lessee.) The Welfare Association rents the Civic Centre from the Ministry of Works which built it (paying an economic rental for the cinema but a nominal rental for the non-profit-making sections), pays ground rent and maintenance charges for the sports-grounds, makes grants and loans totalling £1000 a year to its affiliates, allows them free use of its committee rooms and use of the halls for charges that cover only running costs, and produces the Mangakino Chronicle, a local newspaper with a circulation of about 1100.

The cinema has been in use since early 1948, the rest of the Civic Centre being opened within two years except for the Youth Hall which was completed in 1957. In three years the Welfare Association achieved for Mangakino better facilities than most towns have acquired in a hundred.

KAWERAU

Kawerau is situated in the central Bay of Plenty on the inland margin of the coastal plain, under the shadow of Mt. Edgecumbe. Like Mangakino, it came into being as a direct result of industrial development based on one particular resource, in this case the timber of the Kaingaroa State Forest. Kawerau has a shorter history than Mangakino. It began in 1952, with the incorporation of the Tasman Pulp and Paper Company and the purchase of the mill site.[5] Construction started in 1953 and was completed in 1956, when the mill came into full production. The mill was built on contract by a specially formed combine, Fletcher-Merritt-Raymond, the town by the Ministry of Works, the Tasman Company and contracting firms. At the height of construction, about 1,700

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5. The author wishes to acknowledge the help received from local Kawerau people and from Maoris in surrounding districts.

men were employed in Kawerau, most of them accommodated in single men's camps. Families began to move in as houses were completed and employment became available at the mill. Today the town has a population of 3,800 of whom 1,752 persons (46 per cent) are gainfully employed.

The Tasman mill stands on 400 acres on the eastern bank of the Tarawera River. The land was formerly Maori land and was bought from a local sub-tribe of Ngati Tuwharetoa, members of which still occupy the adjacent district of Onepu, and from Ngati-Awa living at Te Teko. The town was established on a block of Crown land on the opposite side of the river.

Unlike Mangakino, Kawerau was established in a well-settled area, within a short distance of several small rural centres and only 22 miles from the thriving regional town of Whakatane. The main activity of the area is farming. The mill draws its raw materials not from its vicinity but from the logging centre of Murupara 36 miles (by rail) to the south. The site was chosen for its position between Murupara and the deep-sea port of Mount Maunganui and because it offered plenty of flat land, rock foundations, abundant water (the mill uses 10,000,000 gallons per day) and a local source of natural steam power.

From the beginning Kawerau was planned as a permanent town. Unless the newsprint industry suffers unforeseen setbacks, it is certain at least to maintain its present size and may well expand with extensions to the present mills or the establishment of industries to tap the town's reserve of female and teenage labour. The latter is not, however, an inevitable development, because the town has no other local resources and freight charges would raise production costs compared with city factories. Kawerau's houses and public buildings compare favourably with suburban development in New Zealand's cities. Two-thirds of the houses (out of a total of 843 in April, 1960) are owned by the State Advances Corporation, and were built to its specifications in permanent materials. The rest are of a comparable standard: 167 built by the Tasman Company for its employees and 103 privately owned. Kawerau did not grow haphazardly like most other New Zealand towns but was planned in advance, with a central open-court shopping centre and specific areas zoned for industry and commerce. Moreover, it began life with all the amenities of the modern town—tar-sealed roads, sewerage and electric reticulation. In appearance, the town is strikingly new: all the buildings are less than eight years old, there are many vacant sections, especially in the industrial and commercial areas, and several of the public buildings are only temporary. Allied with its newness is a certain uniformity,

which is accentuated by the fact that most of the houses were built by a single agency and also by the nature of the site, which is completely level except for a low plateau on the southern side occupied by a number of executive and private homes.

In its population, Kawerau closely resembles Mangakino. Young married couples with young children predominate. School children and those of pre-school age make up 48 per cent of the population. Little private board is to be obtained in the town because the houses are all family homes with no room to spare. Elderly and retired folk are few: only one person in 18 is over 50. Single men's camps and hostels are a feature of the town. In addition to a staff hostel and two teachers' hostels in the town itself, accommodation is provided for 200 single mill employees and for 150 men employed by independent contractors who work for the Tasman Company from time to time. In April, 1960, the former occupied huts adjacent to the mill but later in the year moved to a new permanent camp nearer to the town. As a result of the numbers of single men employed at the mill, the male-female ratio is unbalanced. Men outnumber women by 100:66. As in Mangakino, the single men are a fairly mobile group. Some family men also move on as their children approach school leaving age because local opportunities for teenagers are limited at present; but for most this is not an immediate problem.

Like Mangakino, Kawerau has a high proportion of both Maoris and immigrants from overseas. The former constitute 42 per cent of the work force at the mill and about 22 per cent of the residents in the town. The difference is due to the number of Maoris who commute daily from surrounding areas. The percentage of Maoris is higher than for any other town except Mangakino. As in most towns, the Maoris belong to many different tribes. The greatest number come from the closer tribal areas, being mainly Tuhoe and Arawa. Both Ngati Kahungunu and Ngapuhi, from Hawkes Bay and Northland respectively, are also present in Kawerau in significant numbers.

The townsfolk depend heavily on the Tasman Pulp and Paper Company's mill for employment. Roughly 75 per cent of the town's workers are employed there; 8 per cent work for the Caxton Paper Company, which stands alongside the Tasman Mill and buys pulp, steam and water from it; and the remainder work in the town's shops and offices, in service occupations or in garages and building businesses. Employment opportunities for women are restricted, though not to quite the same extent as at Mangakino, since the mill employs some in its cafeterias as well as in office work. Kawerau has the same difficulty in placing school leavers. Most of the

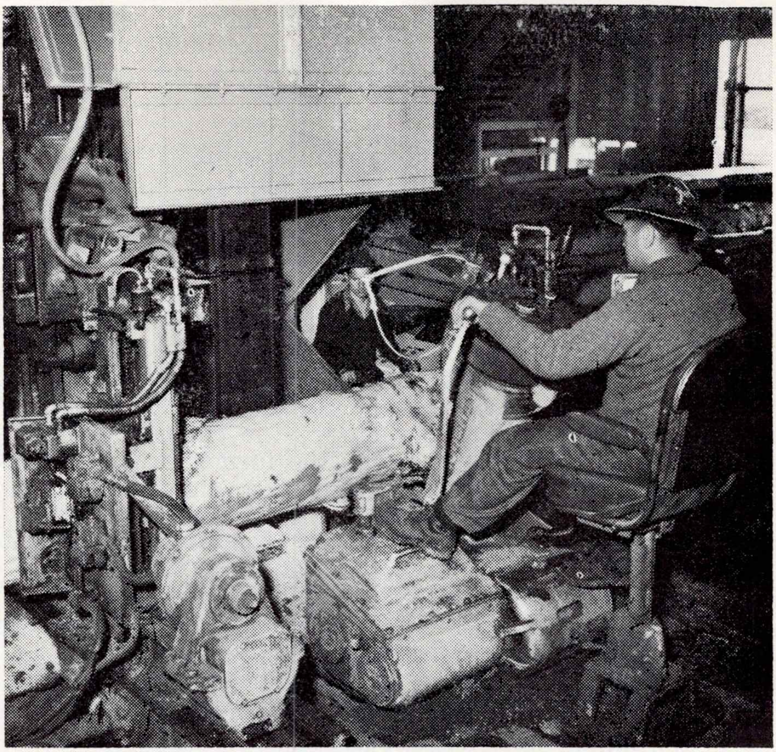

Plate VIII. Maori worker, Tasman Mill, Kawerau.

work at the mill is shift work, and youths may not be put on shift work before they are 18 years old. The mill trains about 16 apprentices each year in a number of different trades, and there are seven apprenticeships available in the town.

The Tasman mill is not really one mill but several, vertically integrated under one management. It comprises a pulp mill, a paper mill, a groundwood mill, a sawmill and a power plant. Together they employ nearly 1,300 workers (1,200 men and 100 women). There is considerable diversity of occupation for males within the mill, though not quite as wide a range as in power-plant construction at Mangakino. Because of the nature of the mill's activities and its high degree of mechanization, plant operators constitute an exceptionally significant proportion of the mill's male work-force—43 per cent compared with 21 per cent of those employed by the Ministry of Works in Mangakino. The pulp, paper, groundwood and timber mills employ 100, 64, 70 and 150 operators respectively; there are 65 in the power plant and some 40 heavy transport drivers. On the other hand, the proportion of tradesmen is very much lower (10 per cent), the range being limited to

electricians and those engaged in engineering maintenance (fitters, welders, plumbers and carpenters). The professional and clerical staff (which includes engineers, chemists and accountants; draughtsmen, laboratory and instrument technicians; and office workers) is also comparatively small. Labourers and handymen account for approximately one-third of the total employed, almost exactly the position they occupy among Ministry of Works employees at Mangakino.

The town itself does not supply the mill with all its workers. Nearly one-quarter of those on the payroll (316 men and 11 women) commute daily to work from surrounding areas. Of these 80 per cent are Maoris. The commuters come from Onepu (28), Te Teko (80), Edgecumbe (30) and Otakiri (37), within a radius of 10 miles; from Matata (19), Whakatane (38) and Taneatua (25), more than 15 miles away; from Rotoma (14) and Rotoiti (30), over 20 miles to the west; and from Ruatoki (12) and Waimana (14), over 40 miles to the east. They travel where possible by their own cars, taking it in turns to carry a full load, or by public transport.

The work at the plant never stops. The pulp and paper mills are operated continuously by four shifts, the wood preparation room is operated by three shifts and the sawmill by two. This has significant implications for family and social life in the town. It dictates household routine, restricts social intercourse between workers on different shifts, and limits attendance at evening functions and the active membership of the many clubs. It also has something to do with the very high standard of house gardens.

As in Mangakino, the average level of income is high in Kawerau. The visitor is impressed with the number of cars owned—well over 700 in a town of 843 households. At meal breaks and the end of shifts a veritable fleet of vehicles takes the road between the town and the mill. The Tasman Company provides houses at a reasonable rental for a high proportion of its workers, owning 167 (April, 1960) and leasing 450 houses as master tenant from the State Advances. It also offers loans to employees wishing to build for themselves.

Kawerau became a fully fledged town while still in the construction stage, being declared an independent borough in 1954. Administered for five years by an appointed Town Commissioner, the borough now has its own Mayor and a Board of Commissioners, consisting of five members elected by residents and three nominated by the Tasman Company (which pays more than two-thirds of the rates), with an Advisory Commissioner appointed by the Government. The Borough Council employs a Town Clerk and a staff of

eight. It recently opened the Borough Council building, which includes a library and a hall at present leased as a cinema.

Though set down in a comparatively well-settled area, Kawerau is too close to several older townships to be able to establish itself as a servicing centre for the surrounding area. Local shops find that 95 per cent of their customers live in the town itself. Many businesses that are a feature of most country towns (shops selling seed and farm machinery, stock and station agents) are conspicuously absent. For a long time to come, Kawerau's prosperity will depend on that of the mill, which, as the major employer, is the main source of the money spent in the town.

The mill dominates the town in other ways, too. People comment that "if you don't watch out you are eating and sleeping with pulp and paper". Shift work rules household routine and social life. In reaction, every weekend sees an exodus of those not at work, to the towns and beaches of the coast or inland to Rotorua. Nevertheless, Kawerau residents already show a lively pride in the town and in the industrial enterprise which is the town's raison d'etre. As one remarked, "We like to get away now and then, but we are always pleased to see the mill's chimneys rise up out of the plain on the way home. The mill looks really impressive when you take a new look at it".

The town is well provided with recreational and social facilities. There are over 60 clubs, and most have land and permanent buildings of their own. The Kawerau Community Association, an executive body elected at a public meeting, played an important part in community life in earlier years, sponsoring clubs and helping them with grants. Today the need is not the same: the clubs are all self-supporting and the Borough Council has taken over many of the Association's functions. But the Community Association still sponsors the publication of a local newspaper and is ready to assist any worthy cause.

Now I would like to consider the changes that the establishment of the pulp and paper mill at Kawerau has had on the lives of individuals. I propose to confine my attention once again to the Maori group, for the reason I gave earlier.

The area in which Kawerau lies is a farming area, distinguished by a large amount of Maori land and a large Maori population. Prior to the coming of the mill, most of the Maoris were farming small family holdings, in most cases at little above subsistence level, and eking out their income with seasonal work at the freezing works. A few found employment in timber mills in Te Teko and Matahina, in dairy factories, on the roads and on the railway.

Today, the Tasman mill provides 263 Maori workers from these areas with employment that is not only permanent and well-paid but in most cases highly congenial. It employs, for instance, 28 men from Onepu, the closest settlement to the mill, and 65 from Te Teko, where 1,200 Maoris live within a two-mile radius. Seven of those from Onepu and many from Te Teko have been diverted from full-time farming; some are still farming in their spare time with family help, but most have leased their land. At first sight it would seem, as one local observer remarked, that "the coming of the mill has been good for us Maoris but bad for the land". But it may prove to be to the ultimate benefit of the land as well, if it removes the reluctant subsistence farmer and makes more land available to the really keen farmers.

The general standard of living has risen noticeably in the settlements from which workers commute to Kawerau. In Te Teko for instance, 30 new houses have been built within the last five years; refrigerators, washing machines and radiograms have become common household equipment, and more time and money is being spent on the improvement of marae facilities. Many Maoris in the area, especially employees of the mill, have taken up cropping as a sideline, growing kumara and watermelons for the Kawerau market. They have invested some of their new wealth in tractors, in order to reduce the amount of labour required.

As a result of employment at the mill, the number of Maoris who have married non-Maoris has increased markedly in Te Teko and other areas adjacent to Kawerau, with the exception of Onepu. An outpost of Tuwharetoa on the borders of both Arawa and Tuhoe territory, Onepu has always been a remarkably self-contained community, and its people still "keep to themselves", unchanged in this respect by the fact that most of the menfolk work at the mill. At present the people of Onepu and the immigrant Maoris in the town are linked together in a single Tribal Committee; but their interests and needs are quite different and it is uncertain how long the arrangement will last.

Passionately attached to their ancestral lands, the Maoris of the central Bay of Plenty are grateful to the Tasman mill for employment which allows them to remain in their home communities. Work at the mill has stemmed emigration and brought home some forced to emigrate earlier by lack of work. Experience at the mill has resulted in the gradual development of a movement towards Kawerau in the area as a whole, with the exception of Onepu. Some families have moved into the town (from as close as Te Teko as well as from further afield), and others into settlements closer to Kawerau than their own. The people of Ruatoki and

Waimana, which are almost exclusively Maori districts, have in the past firmly resisted persuasion to move closer to places where work is available, but they themselves are beginning to realize that the cost of commuting daily to Kawerau is unduly high. Commuters from Ruatoki and Waimana spend upwards of one-sixth of their wages in travelling expenses; the physical strain of travelling is heavy, and their long absences adversely affect family and community life. Some have already moved and others are contemplating moving into Whakatane, Taneatua and Te Teko, and a few into Kawerau itself. They are still close enough to be able to go home for important community gatherings. The general effect of this movement towards Kawerau has been to increase the proportion of immigrants from other tribes and sub-tribes in the districts close to Kawerau, modifying their character considerably.

In Kawerau itself, a new multi-tribal community has come into being. Many of the Maoris in the town (a much higher proportion than in Mangakino) come from farming areas where the population is predominantly Maori. They were not only unfamiliar with industrial employment when they arrived, but they had in many cases never lived or worked in close association with non-Maoris before. As one said to me, "living in Kawerau has been an education for us. Some of us had never had Pakehas as neighbours or friends before." (It is also an education for most of the Pakehas, for the Maoris keep up their traditional practices, visiting a bereaved household to "pay their respects" and escorting the bereaved family home after a funeral, to the accompaniment of "karanga" (calling) and "tangi" (wailing)). In general according to a staff member, the Kawerau Maoris have quickly adapted themselves to regular working hours and shift work.

The many different tribes manage to get on very well together in Kawerau. Drawn together by their common situation as Maoris away from home, they have formed a Kawerau Maori Community Association, the main objects of which are to help all Maoris living in Kawerau when in difficulties and to work for a marae in the town. They have been invited to use the Onepu marae, but they feel that they are only visitors there. They want a marae of their own, close to their homes. The Maoris working at the mill also have a co-operative Maori Welfare Committee, which helps members at times of sickness and death.

The Maoris I spoke to said that while some people in Kawerau were "too busy making their fortunes", they find most friendly and helpful. Some discrimination exists but "it's not enough to make a fuss about". And Kawerau is a

town of opportunity. Those who arrived in the early years are proud that they "grew up with the town". "The first months we lived here, our hearts were back home, but now it is like a paddock that has been ploughed and sown and now we are taking grass off it."

THE FUTURE AND TAHAROA

Mangakino and Kawerau are both new towns which were established as a result of the development of particular local resources and which grew rapidly in a very short time to join the ranks of New Zealand's largest country towns. They differ in some respects, but in many others they have more in common with each other than with most other towns of their size. A few similar towns already exist in other parts of the country, and the development of certain resources is likely to give rise to others in the future. For that reason, I would like to conclude with a brief reference to a place that has been mentioned in two of the lectures in this series: Taharoa, the site of the largest and most exploitable of the ironsand deposits.[6]

At present, Taharoa is one of the most isolated communities in New Zealand, being completely without road access. Mail and provisions come once a week from Te Kuiti by truck and boat across the lake, but to leave Taharoa the people must ride eight miles through the hills to Te Maika, whence a daily launch plies across the harbour to Kawhia. Internal communication is by horse and sledge; the scattered households are linked by bridle paths cut through tea-tree and lupin scrub or zigzagging over the steep hill pastures. The land (including the ironsands) is entirely Maori owned. The inhabitants are all Maori: 88 persons distributed among 16 households and belonging (with the exception of the schoolteacher's family) to four closely related family groups. Inevitably the community is highly self-contained. Yet although every piece of timber and every stick of furniture has come in by boat and sledge, and every bale of wool goes out by the same route, the houses (though not new) are solidly constructed and roomy, most have telephones, radios and kerosene refrigerators, and the people make a fair living from sheep-farming.

Taharoa stands on the threshold of industrial development. Just how extensive it will be is still uncertain. It may result in the establishment of a town comparable to Kawerau or merely a village of workers engaged in mining and ship-

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6. The author is grateful to the people of Taharoa for their hospitality and assistance.

ping the sand. But whatever form it takes it will constitute, in the words of one "kuia" (elderly woman) an "earthquake" in the lives of the local residents. Not surprisingly, they themselves view the likely future with mixed feelings. The old folk hope that development will not come in their time, because they know it will mean the passing of their familiar way of life and the incursion of the Pakeha and the modern world. They are afraid that it will involve not only the ironsands but more and more of the good land, and that their descendants may be tempted to sell. The younger people can see the advantages. They like the prospect of local employment which would bring emigrants back and provide work at home for youngsters now growing up. Income from royalties will be useful, though not a major consideration because they must be shared with many absentee owners. Most favour the ironsands development mainly "because it will bring the road in": a road will cut high freight and travelling costs, increasing the return from the land, and make it easier both to visit the outside world and to obtain labour in the busy seasons of the year. But they also realize that community life will be affected. "We will separate and won't know each other so much." And strangers will have free access to the riches of the seashore.

Only time will tell what will happen at Taharoa. The examples of Mangakino and Kawerau suggest that while new single-industry towns have their own peculiar problems, they also have many real advantages as a place to live. But it is well to remember that in the course of their establishment many changes and many heartaches are imposed upon the original inhabitants.

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APPENDIX 2.1
POWER RESOURCES OF NEW ZEALAND
THE PROBLEM OF LOAD FACTOR

The load factor of a system is the ratio of the kWh actually used to the kWh which would have been used if the maximum load had been continuous. It is generally expressed as an annual load factor, and a numerical example will make it clear.

In the Waitemata Power Board's area, for example, the annual consumption for 1960 will be about 260,000,000 kWh, and the maximum demand on the system 52,000 kW. If this demand had been continuous for the year, the consumption would have been 52,000 x 8760 kWh. So the annual load factor is

$$\frac{260{,}000{,}000}{5200 \times 8760} = .57 \text{ or } 57 \text{ per cent}$$

The plant factor of a generating station is the ratio of the kWh actually generated to the kWh which would have been generated if the maximum output of the station had been maintained continuously - in fact, it is the load factor of the station.

With hydro stations, it is usual, and economic, to design the station so that the plant factor of the station matches the load factor of the system. In New Zealand, the system load factor is about 55 per cent and the hydro stations have been designed for a plant factor of this value. Another numerical example will, perhaps, make this clear. The water storage of the Whakamaru hydro station has been designed to enable the station to give an output of about 480,000,000 kWh per annum. This output only requires 55,000 kW of generating plant. But, to cope with short periods of peak load, 100,000 kW of generating plant has been installed.

In short, enough generating plant is required, not only to provide the number of kWh of energy represented by the average load on the system, but also to supply the maximum peak loads, which occur daily and seasonally. Thus it will be seen that when the plant factor of the station matches the load factor of the system, there is sufficient peak load capacity in the generating plant to meet the maximum loads occurring on the system.

A different situation arises when generating stations which have an inherently high plant factor make substantial contributions to a predominantly hydro system. Geothermal, nuclear, and to a certain extent, coal-fired steam stations are efficient only at high values of plant factor. Geothermal steam plants operate at 80 to 85 per cent of plant factor; nuclear at about 90 per cent and, for reasonable efficiency, coal-fired steam stations should operate at from 70 to 75 per cent. The result of these high plant factors supplying a lower system load factor is that additional plant must be installed to provide for peak load requirements. For example, for every 100 MW of geothermal steam plant installed and operating at 80 per cent plant factor, 50 MW of complementary peak load plant must be provided.

Since this peak load is only called on to operate for very short periods - usually about 5 per cent plant factor - it is essential that its capital cost be low. Its fuel cost is relatively unimportant.

This raises the question as to the most suitable type of plant for peak load stations. The essential features are low capital cost; quick starting to full load conditions; operation with small staff; capable of supplementing base load supply during periods of water shortage and location close to large loads. There are two available methods, which could be used in New Zealand. The first is to install additional machines in existing hydro stations, which would be used for peak load running only, and to build special hydro stations for this purpose only. These stations would be designed as run-of-the-river stations, and would not have the water storage required for base load stations. The second alternative is to install low cost gas turbine stations operated on oil fuel.

The first scheme makes use of the resources of the country, but suffers from the disadvantages of high capital cost (up to £150 per kW), unsuitability for supplementary base load supplies in dry weather, and, as a rule, remoteness from load centres. Its main advantage is in the conservation of overseas funds, both for construction and fuel. So far, it is the policy adopted by the present government. The other alternative has the advantages of low capital cost (about £35 to £40 per kWh), independence of weather conditions, and ease of installation close to load centres. It was the policy adopted by the previous government. Discovery of good oil supplies in New Zealand, or the development of gas turbines using pulverized coal would give an overwhelming advantage to the gas turbine alternative but it is likely, in the long run, that both these methods will be used and both will be needed.

APPENDIX 4.1
FORESTS AND FOREST INDUSTRIES
MECHANICAL AND CHEMICAL PULPING

Pulping, that is, the separation of wood fibres, is achieved by either mechanical or chemical methods. The result of the former process is a fibrous pulp known as groundwood, since the wood is torn apart under pressure of grinders. Heart-free sap logs, no greater than 16 inches in diameter and cut into 2 to 4 feet lengths are preferable, since the lower the resin content of the wood, the more efficient the process. Fibre yield is high — about twice that of the chemical method — but fibres are short, brittle, and suitable only for newsprint or cheap wrapping papers.

In the chemical method, on the other hand, bark-free chips are cooked under pressure in a liquor containing either of two chemical combinations. In this way the pure cellulose remains after the impurities — lignins, sugars, gums, resins and mineral salts — have been removed. Long, slender, and flexible fibres, stronger than those produced by the mechanical method, are a feature of such pulps, which are used to make the better grades of paper. At Kawerau, the newsprint contains groundwood and chemical pulp in the proportion of four to one. Power, therefore, accounts for most of the cost in the production of mechanical pulp, as against that for chemicals required in the alternative process.

Most common of the three chemical procedures is the sulphite method used for spruces, firs and hemlocks. Only softwood species with a low resin content may be pulped in this manner since the calcium bisulphite liquor, being acidic, dissolves the lignin but not the resin or the pitch. By contrast, highly resinous woods such as pines are cooked in an alkaline combination of sodium sulphide and caustic soda. The result, sulphate or kraft pulp, contains the longest fibres of the three, and therefore produces the strongest sheet of paper. Sodium sulphide and caustic soda also form the cooking agent of the third, or soda process, which is used to pulp short-fibred hardwoods. Fibres are both bulky and opaque, and are thus well-suited to the making of book papers.

Because radiata pine is used in the sulphate process, the newsprint made at Kawerau is stronger than that produced in other countries whilst the porous and opaque nature of the sheet reflects the high groundwood content. Canadian and Scandinavian newsprints, on the other hand, are produced more cheaply, since the lighter colour of the sulphite pulp eliminates the bleaching necessary before the kraft can be added to the groundwood.

APPENDIX 7.1

THE ROLE OF CONSUMER INDUSTRIES

ASSURING A MARKET FOR PRIMARY AND SECONDARY INDUSTRIES: ITEMS UNDER IMPORT SELECTION, 1938-1957

The following list sets out, by commodity groups, those items or commodities made in New Zealand which have been assured of a major share of the New Zealand market by import selection since the introduction of the licensing system in 1938. The items listed also remained under import licensing during the exchange control in the early 1950s. That is, these are the products of New Zealand's primary and secondary industries which were assured a market by import selection by successive administrations from 1938 to 1957. From this date onwards the balance of payments crisis altered the picture because the need to save foreign exchange became acute and imports had to be severely reduced. In some cases the import allocation provided has varied from year to year; the items, however, are listed according to the allocation which has predominantly applied over the years. Certain of the items included were not subject to import licensing in some periods, and these have been noted.

The various terms used are:—

"D" item — no import allocation provided and licences granted only in exceptional circumstances.

"SD" item — no allocation provided but applications considered for licences to import particular goods of a kind not made in New Zealand.

"OD" item — limited provision made for imports from other than scheduled countries.

"C" item — applications considered individually.

"T" item — token licences granted for the importation of specific goods from the United Kingdom, to the extent of 20 per cent of 1938 imports of the same goods, from the same supplier.

"E" item — exempt from the requirement of a licence when imported from and being the produce of any country other than scheduled countries.

A "scheduled country" is one from which imports were more strictly limited, the most notable cases being those in the dollar area.

AGRICULTURAL PRODUCTS, FOODS AND GROCERIES

With some minor exceptions all farm products - pastoral, agricultural, horticultural - had a market protected by quantitative regulation of imports. Of this group in the Import Schedule, 24 commodities, throughout the period, received a major share of the New Zealand market through import licensing. They are:

"D" Items:- Honey; Fresh fruit; Fresh vegetables; Dried apples; Sauces, viz:- tomato, tomato and apple, Worcester "T" item; Spaghetti and alimentary pastes, cooked "T" item; Sugar of No. 22 colour; Treacle, golden syrup, maple sugar, maple syrup.

"SD" Items:- Lemon juice; Coconut butter and other vegetable butters; Stearine for candle and similar manufacture; Spices, ground "T" item; Essences, culinary "T" item.

"C" Items:- Pearl barley; Lucerne seed; Lemon juice in bulk; Grape juice; Citrus fruit pulps; Grapes, fresh; Fruit pulps, viz:- apricot, raspberry, tomato; Jams, jellies, marmalade and preserves; Chutney; Lemon cheese, lemon butter, lemon honey; Sugar n.e.i.
It is in the "C" group that the greatest variation in the licensing allocations has taken place. The following items were exempt from licensing for the periods shown:-
Pearl barley - exempted in 1951, control reimposed June 1954; Jams, jellies, marmalade and preserves - exempted in February 1954, control reimposed 29 October 1955.
In addition, the following goods or commodities are included in the list of Prohibited or Restricted Imports and may not be imported except with the consent of the Minister of Customs.
Egg - pulp and white or yolk of eggs whether dessiccated, liquid, frozen or other, also any similar preparation of eggs;Fresh fruit, namely oranges, mandarin oranges, grapefruit, lemons, bananas; Fresh pineapples; Fruit and vegetables (other than dried, canned, pickled, pulped or bottled fruit and vegetables) grown or produced in the Commonwealth of Australia; Kumaras; Onions.
Stock foods as follow:-
Barley, including cracked, broken, kibbled and hulled barley; Bran, pollard and sharps; Coconut meal and copra cake; Cotton seed meal; Hay, straw and chaff; Hemp seed; Linseed, crushed and linseed meal; Maize, including maize ground or crushed, but not otherwise manufactured; Manioc flour or meal, being ground unrefined tapioca root, also known as cassava root; Oats; Plant products in forms suitable for feeding to stock; Rice meal, rice meal refuse, unpolished rice and rice by-products; Seed, subterranean clover; Soya beans, soya bean meal and soya bean cakes; Any grain processed or unprocessed not elsewhere mentioned, in a form suitable for feeding to stock.

Wheat and wheat flour, including wheat-meal and similar preparations of wheat within the meaning of Items 4(2) and 5(9) of the Customs Tariff of New Zealand may not be imported otherwise than in pursuance of a written permit issued by the Minister of Industries and Commerce, save with the consent of the Minister of Customs.

Imports of meat preserved or otherwise processed into any meat product or any portion of the carcass of any stock which has been manufactured into meat meal, bone meal, bone flour, or other food for stock or poultry, other than animal manure, may not be made except with the authority of the Minister of Agriculture. The importation of sausage casings of animal origin, and wool, including fleece wool, imported from the United Kingdom, is also prohibited except in accordance with certain regulations.

SPIRITS AND ALCOHOLIC BEVERAGES

Only one item under this heading has been subject to import licensing at all times over the years. This is:- wine - other kinds (excluding wine containing not more than 25 per cent of proof spirit, imported in bottles; liqueurs).

DRUGS, CHEMICALS, SURGICAL, DENTAL AND SCIENTIFIC APPARATUS

In this group 10 items of New Zealand manufacture have enjoyed a major share of the New Zealand market.

"C" Items:-

Weed and scrub killing preparations (excluding sodium trichloracetate); Disinfectants n.e.i. including coal-tar acids in combination with alkalis to form solutions which will give saponaceous disinfectants upon the addition of water (excluding cresylic acid, phenol, mono-chlorxylenol, corrosive sublimate tablets, sodium ortho-phenylphenate, quaternary ammonium compounds - "T" item). Colloidal sulphur; Insecticides and

fungicides for agricultural uses — Dalmatian powder, powdered hellebore and powdered derris root, in packages of not less than 5 lb net weight; Concentrated extracts of pyrethrum and derris root, also mixtures of such concentrated products; Zinc oxide; Cleansing preparations, being combinations of inorganic salts of the same metallic element; Silver nitrate; Caustic soda in packages of 7lb and under; Hydrated lime (calcium hydroxide), naphthenates of cobalt, lead, manganese, zinc, copper and other minerals; Dry white lead. Dry white lead was made exempt from import licensing in 1954 and control was reinforced in 1954.
"D" Items:-
Hop oil.
"SD" Items:-
Anti-incrustation, boiler and similar compounds (excluding anti-incrustation and similar compounds for use on heating surfaces in fire boxes.) Solutions of hypochlorites.

TEXTILES, CLOTHING, DRAPERY

Since 1938 there has been a substantial development in New Zealand industry under this group and as domestic production has expanded it has been necessary to vary commodity headings and import licence allocations to ensure New Zealand made goods their share of the market. Because of the wide variation it is not practical to group commodities under D, SD, C, etc., headings.

In 1954 the Board of Trade introduced a system of "OD" licences which aimed at permitting limited imports of goods of a type which were being made in New Zealand by well established industries, and a number of these "OD" licences were issued for apparel items. The year in which "OD" licences were first issued for a particular item is given in brackets.

Commodities in the textile, clothing and drapery group which from 1938 to 1957 received a major share of the New Zealand market are:-
Shirts (1954); Men's & boys' pyjamas (1954); Ladies' nightwear (1954); "Work" gloves composed wholly or principally of leather; Gloves and mittens (other than "work" gloves) of leather; "Work" gloves other than of rubber or asbestos; P.V.C. Industrial protective clothing; Men's and boys' shorts & overalls (1957), Men's & boys overcoats, suits, coats, trousers, waistcoats, dress vests, pure linen suits, kilts (1957); Men's socks of silk, artificial silk, nylon, etc. (exempt from 1951 to 1956); Men's heavy working socks; Boys' ¾ hose; Children's socks and stockings; Women's and girls' ankle socks (exempt from 1953 to 1956); Hosiery - other (1954); Blouses (1954); Women's fully fashioned stockings; Women's and girls' outer garments of woven fabrics (1954); Knitted underwear of wool, Knitted outerwear of wool: cardigans, jumpers, etc., Children's, maids' and youths' sizes up to 32", Men's sizes 34" and over, Women's sizes 34" and over; Knitted outerwear of wool other than cardigans etc., and including knitted dresses and frocks; Bathing costumes, bathing robes, dressing gowns, knitted shirts, etc. (1954); Bags and sacks of textile or felt; Corn sacks, bags or sacks of New Zealand tow or flax; Wool Packs and wool pockets; Buttons; Rubber Mats; P.V.C. industrial protective caps; Hats and caps etc. (1954); Milliners' petershams with unbound edges; Millinery, all kinds (1954); Textile piece-goods, woven, of jute; Circular knitted artificial silk piece-goods; Knitted cotton piecegoods; Wool jersey fabric; Knitted woollen piece-goods other than woool jersey; Textile piece goods n.e.i. of wool (woollen piece-goods) - made E in 1951, recontrolled 28 October 1955; Handbags or purses of textile; Garment protection covers, robe sets, bags, toilet or shopping, of textile, paper cleansing tissues, powder puffs, rucsacs of textile; Umbrellas, parasols and sunshades (other than of paper) - limited licences issued in 1957; Yarn - jute - flax and hemp - sisal and raffia.

LEATHER, LEATHER MANUFACTURES, GRINDERY AND RUBBER GOODS

"D" Items:-

Rubber gloves, household type; Rubber tyres, of sizes made in New Zealand; Rubber tiring for bicycles and perambulators.

"SD" Items:-

Rubber mats; Hose, plastic and rubber; Hot water bottles and hot water bags of rubber (excluding those in novel shapes, such as animals, designed for use by children; fittings, viz:- stoppers, necks and neck bands for hot water bottles — "T" Items).

"C" Items:-

Boot, shoe and slipper heels, knobs and soles of rubber; Wooden heels; Hose tubing and piping, flexible, of canvas, etc. (excluding plastic, canvas and flexible metal hose, tubing or piping); Leather - persians; Ladies' handbags, lined (1954); Plastic gloves; Rubber and gutta percha solutions and cements; Solid rubber tyres; Fibre stiffeners; Portmanteaux, trunks, bags of textile, etc. (1954).

FOOTWEAR

For a number of years before 1956 no imports of conventional type footwear were permitted. Licences were, however, granted for special types of footwear not made to any extent in New Zealand, e.g. ski boots, ice-skating boots, ballet shoes, canvas and rubber boots and shoes. No analysis of categories is attempted in this group because the headings for footwear and the import allocations made in the import licensing schedules have been subject to many variations in recent years as the New Zealand industry has expanded. In 1956 "OD" licences were available which provided for imports equivalent to approximately 10 per cent of New Zealand production of adult footwear. The licences were granted in three categories:-

Slippers; Women's and maids' (exceeding children's size 13); Men's and youths' (exceeding children's size 13).

Licences were granted on a quantity basis, not value, to prevent large imports of cheap footwear from low-cost countries flooding the market.

Import licences have always been availabl on a fairly generous scale for children's footwear, particularly in the smaller sizes. In 1957 children's footwear in the following sizes were exempt from the requirement of an import licence.

(a) Children's footwear sizes 0 - 6. (b) Children's footwear exceeding size 6 but not exceeding size 9.

GLASS, CHINA, EARTHENWARE, STONE AND CEMENTS

In this group seven items of New Zealand manufacture continued to have a share of the New Zealand market reserved for them.

"D" Items:-

Earthenware chambers; Mixing bowls and pudding basins.

"C" Items:- Plaster pulp sheets; Cement, Portland; Chinaware, earthenware and porcelainware; Sanitary ware, white; Rear-view mirrors for motor vehicles.

FANCY GOODS, MUSICAL INSTRUMENTS, SPORTING GOODS PHOTOGRAPHIC GOODS

In this group 10 commodities continued to have guaranteed the share of the New Zealand market indicated by the category.

"D" Items:-

Racquets - tennis (excluding fully strung tennis racquets the f.o.b. price of which does not exceed 7/- sterling) - badminton - squash;

Golf clubs; Golf bags; Toys (excluding specified toys not made in New Zealand — "T" item).1
"SD" Item:-
Footballs and basketballs (excluding bladders).
"C" Items:-
Finished component parts of golf clubs, for use only in the repair of golf clubs (excluding steel shafts, sole plates and grips); Parts for the manufacture of toys; Combs, hair and toilet — "T" Item.

PAPER AND STATIONERY

In this group a substantial number of commodities continued to be subject to import selection. The following 20 items are the main ones concerned:-
"SD" Items:-
Cream mugs and honey jars of cardboard - "T" items; Cardboard boxes and paper boxes, complete paper and cardboard cut to shape for wrappers, boxes and other receptacles; Cardboard, pasteboard, woodpulp board, corrugated board, fibre board, strawboard and similar board, etc; Envelopes and bags of celluloid or similar materials and wrappers made from such materials, printed, lithographed or ruled, n.e.i.; Paper, n.e.i., etc. in rolls less than 10 inches wide; Gummed stay paper and gummed paper tape, other than self adhesive tape in rolls; Stationery and paper manufactured - "T" item; Cards, printers' menu, programme, calendar, Christmas and similar of cardboard, celluloid or similar material.
"C" Items:-
Building board; Box ,carton and container board, including strawboard, plain and corrugated; Envelopes and bags, paper, n.e.i.; Handbills, circulars, programmes, playbills; Ink, printing, n.e.i. - "T" item; Paper pulp for paper manufacture; Paper seed pockets, printed, for packing seeds; Paper waxed, unprinted, also such paper printed and then waxed - "T" item; Wrapping paper, specified sizes and weights; Wrapping paper, n.e.i.; Wrapping paper, glazed.

METALS AND MACHINERY

This group covers a wide range of items. Only the more important commodities subject to import licensing have been listed. These number 36.
"D" Items:-
Wireless broadcasting receiving sets - "T" item; Fluorescent lamps, complete; Refrigerators.
"SD" Items:-
Rubber washers; Transformers for radio sets; Insulators - "T" item; Valves and cocks, taps, tobies, hydrants and similar articles of brass and other copper alloy; Electric heating and cooking appliances - "T" item; Shovels, size 2 - 10, round or square mouth, long or D handled - "T" item.
"C" Items:-
Bolts and bolt ends up to 24" in length; Metal thread screws of brass up to $\frac{1}{4}$" diameter; Metal thread screws of steel; Galvanized iron manufactures; Tines, ploughshares, plough parts; Cultivators, harrows, ploughs, drills, seed and fertilizer sowers, seed and grain cleaners - "T" item; Agricultural implements n.e.i. including swathe turners and side delivery rakes, hay and wool presses, chaff cutters,

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1. In 1960 it was decided that licences issued for toys of types not made in New Zealand (e.g. Meccano sets, model building sets, model train sets, etc.) may be used for the importation of toys classified under the "D" heading. This was done because of the increasing difficulties encountered in administering the toy item.

potato diggers and sorters, fruit grading machines, electric fence chargers, garden tools; Milking machine parts of rubber - "T" item; Power distribution transformers - "T" item; Plug sockets or outlets, switches of plastic; Electrodes for electric welding; Insulated cable and wire; Incandescent filament electric lamp bulbs - "T" item; Blowers and fans; Convector heaters, glasshouse heaters; Jaw crushers; Winches, cranes, and hoists - "T" item; Piston rings; Washing machines, other than domestic; Aluminium hollowware; Barbed fencing wire; Metal cordage, and copper and tinned copper; Nails and tacks exceeding one inch - "T" item; Nails, lead headed; Lead traps and bends; Metal wove wire; Electrically welded wire fabric.

VEHICLES, ETC.

Excluding motor vehicles, the following five items have continued to be subject to import licensing - all were "C" items:-
Perambulator wheels not exceeding 9 inches diameter; Hubs, spindles and other finished, partly finished or machined parts for tricycles; Tricycles, chain driven; Perambulators and like vehicles; Undercarriage springs of the leaf type.

MOTOR VEHICLES

By 1957 the motor vehicles subject to licensing were:-
Motor vehicles unassembled or completely knocked down (excluding tyres) - except chassis for commercial vehicles (including omnibuses) of specified gross weights, etc. Motor vehicles n.e.i. other kinds (except straddle trucks; commercial motor vehicles of specified gross weights).

GREASES, OILS, PAINTS, POLISHERS, WAXES, ETC.

Of the 22 items in this group subject to import licensing through the years all but two have been classified as "SD", and licences granted only where specific types were not made in New Zealand.
"SD" Items:-
Strip greases; Lubricating greases (excluding petrolatum); Coconut oil; Paints mixed ready for use - "T" item; Paints and colours, ground in liquid - "T" item; Paint thinners - "T" item; Putty and wood fillers (excluding glazing putty for metal sashes) - "T" item; Varnishes (excluding collodion-base varnish for correcting stencils), also:- Lacquers, Brunswick black, Japans, Lithographic varnishes, Printers' ink reducer,Terebine, Gold size, Liquid stains for wood, Metallic paints and liquid medium, Petrifying-liquids n.e.i. suited for water-proofing concrete, plaster and similar surfaces, or for use as paint, Fused gums for manufacture of varnishes (excluding brewers' pitch); Paint removers (excluding glazing putty for use on metal sashes); Beeswax.
"C" Items:-
White lead ground in oil; Whiting and chalk.

TIMBER, WOODENWARE, FURNITURE, WICKERWARE

Items in this group were gradually exempted from import licensing over the years and by 1957 most goods could be imported without licence from world sources with the following three exceptions:-
"SD" Item:-
Basketware, wickerware, imitation wickerware, and similar ware; wicker, bamboo and cane furniture, and imitations of the same.
"C" Items:-
Doors, wooden plain or glazed; Plywood.

MISCELLANEOUS

In this group the following items continued to be assured of a market over the period:-
"D" Items:-
Reaper and binder twine; Crown seals - "T" item; Agar agar.
"C" Items:-
Shaving brushes; Paint brushes; Brushes, brushware and brooms; Fireworks; Collapsible metal tubes; Corrugated saw-edge fasteners; Kraft

paper, ungummed, of approved qualities, in rolls exceeding 10 inches wide, for use in making gummed paper; Kraft paper for use in making combination kraft-lined container board; Manila paper, etc., for making envelopes; Papers, kraft or tissue, for making laminated plastic sheets; Wrapping paper for making corrugated strawboard; Slide fasteners of metal track on tape of cotton or other textile; Tanners bates; Rubber in sheet, strip etc;Cellulose cements; Insulating building board; Lemon and orange rinds; Roofing compounds, bituminous; Sheep marking oils and fluids.

APPENDIX 7.2

IMPORT SUBSTITUTION - FIVE INDUSTRIES, 1950-51 to 1957-58

Long and intricate research would be needed to show the net saving in overseas exchange achieved by New Zealand manufacturing as a whole, but we can examine specific industries to see what net exchange saving they have made by their existence at their output over a given period.

In the following tables I have set out the value of New Zealand production in various industries over the past eight years and deducted the cost of raw materials and plant used by them. I have assumed that all the materials and all the plant and machinery used by the industries specified have been imported. This is an obvious exaggeration. So also is the assumption that all plant and machinery used is paid for in the year specified from current receipts of overseas funds rather than imported on a non-remittance basis, financed by overseas investment. To offset this, I have made no allowance for the fact that the imported finished product - if it had entirely replaced the New Zealand product - might have been lower in price. But in any case the exchange saving is so substantial that the imported price would have needed to be very much lower to have made much difference to the results.

These assumptions must be made for our statistics are, inevitably, insufficiently refined to avoid them.

RADIO ASSEMBLY

	Cost of Materials £(000)	Cost of Plant and Machinery £(000)	Value of Output £(000)
1950-51	1,000	14	1,690
1951-52	1,259	20	2,056
1952-53	1,352	23	2,129
1953-54	1,608	24	2,571
1954-55	1,631	20	2,655
1955-56	1,756	21	2,787
1956-57	1,727	16	2,680
1957-58	2,137	21	3,249
Totals 8 years:	12,470	159	19,817
Combined cost of materials, plant and machinery			12,629
		Difference	7,188

The net exchange saving over the eight years was therefore £7,188,000.

CLOTHING INDUSTRY

	Cost of Materials £(000)	Cost of Plant and Machinery £(000)	Value of Output £(000)
1950-51	13,962	245	23,233
1951-52	16,517	368	26,703
1952-53	15,570	214	24,791
1953-54	15,518	198	25,691
1954-55	17,851	274	29,649
1955-56	17,791	311	30,217
1956-57	16,761	252	28,951
1957-58	18,229	389	31,454
Total 8 years:	132,199	2,251	220,689
Combined cost of materials, plant and machinery			134,450
		Difference:	86,239

The net exchange saving over the eight years was £86,239,000 on the assumptions I have mentioned. In fact, however, New Zealand woollen piece goods contributed a substantial share of the materials used.

RUBBERWARE INDUSTRY

	Cost of Materials £(000)	Cost of plant and Machinery £(000)	Value of Output £(000)
1950-51	1,950	272	4,318
1951-52	4,336	220	7,173
1952-53	2,937	272	5,086
1953-54	2,780	210	5,722
1954-55	3,513	257	7,352
1955-56	4,274	254	8,265
1956-57	4,623	313	8,683
1957-58	4,464	275	8,874
Total 8 years:	28,877	2,073	55,473
Combined cost of materials, plant and machinery:			30,950
		Difference:	24,523

The net exchange saving over the eight years was £24,523,000.

PAINT AND VARNISH

	Cost of Materials £(000)	Cost of plant and Machinery £(000)	Value of Output £(000)
1950-51	2,252	39	3,250
1951-52	3,039	64	3,960
1952-53	2,917	48	3,779
1953-54	2,899	25	3,996
1954-55	3,285	42	4,703
1955-56	3,400	171	4,838
1956-57	3,593	144	5,147
1957-58	3,799	41	5,398
Totals 8 years:	25,194	574	35,071
Combined cost of materials, plant and machinery:			25,768
		Difference:	9,303

The net exchange saving over the eight years was £9,303,000.

ELECTRICAL MACHINERY APPLIANCES
n.e.i. Repairs

	Cost of Materials £(000)	Cost of plant and Machinery £(000)	Value of Output £(000)
1950-51	1,911	55	3,424
1951-52	2,559	87	4,251
1952-53	2,650	155	4,593
1953-54	2,921	80	5,222
1954-55	3,367	105	6,026
1955-56	3,506	103	6,300
1956-57	3,705	138	6,420
1957-58	4,226	101	7,403
Totals 8 years:	24,845	804	43,639
Combined cost of materials, plant and machinery:			25,649
		Difference	17,990

The net exchange saving was almost £18,000,000.

APPENDIX 8.1

INDUSTRIAL DEVELOPMENT WITHIN THE AUCKLAND METROPOLITAN REGION

MAJOR MANUFACTURING PROJECTS IN THE REGION

(Commenced or planned between January, 1958 and June, 1960)

PRODUCTS	NAME OF FIRM	
MACHINERY AND APPLIANCES		
For industrial and commercial purposes:		
Fork-lift trucks, self propelled	Cable Price Corp. Ltd.	New
	Mason Bros. Ltd.	New
Oil filters	Wix Corp. (N.Z.) Ltd.	New
Pistons, valves and piston rings	Associated Engineering N.Z. Ltd.	Expansion
Oil filters and mufflers	Motor Specialties Ltd.	Expansion
Ignition coils	Joseph Lucas and Co. Ltd.	New
Forage harvesters	D. Mcl. Wallace Ltd.	New
Electric fence chargers, mains operated	Hooker and Co. Ltd.	New
Boilers	Cable Price Corp. Ltd.	Expansion
	Mason Bros. Ltd.	Expansion
Welding electrodes	N.Z. Industrial Gases Ltd.	Expansion
Fractional horsepower electric motors	Fisher and Paykel Ltd.	Expansion
Laundry equipment	Horscroft (N.Z.) Ltd.	New
Weighbridges	Accurate Scale Co. Ltd.	New
Fire extinguishers	Wormald Bros. Ltd.	Expansion
Shipbuilding	Mason Bros. Ltd.	Expansion
Bow saws	John Shaw Manufacturing Ltd.	New
Thermostats	Fisher and Paykel Ltd.	Expansion
Industrial vacuum cleaners	Tellus Vacuum Cleaners (N.Z.) Ltd.	Expansion
For domestic purposes:		
T.V. receivers	All manufacturers of domestic radio receivers	New
Motor scooters	J.N.Z. Manufacturing Co. Ltd.	New
	Mr J. H. F. Stewart	New
Kerosene heaters	H. J. Ryan Ltd.	New
	Kent Engineering Co. Ltd.	New
	F. W. Cave Ltd.	New
Fluorescent tubes	Thorn Electrical Ltd.	New
Domestic sewing machines	Knitwear Machinery and Supplies Ltd.	New
Floor polishers	Fisher and Paykel Ltd.	New
	Boyes and Rosser Ltd.	New
	Direct Imports (N.Z.) Ltd.	New
	Richard Barry and Sons Ltd.	New
Electric steam irons and pop-up toasters	Ultimate Ekco N.Z. Co. Ltd	Expansion
Steam irons	Fisher and Paykel Ltd.	Expansion
Electric steam irons and frypans	Dominion Radio and Electrical Corp. Ltd. and	Expansion New
Electric shavers	Allied Industries Ltd.	New
Pop-up toasters	Dominion Radio and Electrical Corp. Ltd.	Expansion

Vacuum cleaners	Fisher and Paykel Ltd.	Expansion
Washing machines	Fisher and Paykel Ltd.	Expansion
Dish-washing machines	Fisher and Paykel Ltd.	Expansion

METAL MANUFACTURES

Merchant bars	Pacific Steel Ltd.	New
Wire rope	British Ropes Ltd.	New
Foil containers	The Colonial Ammunition Co. Ltd.	Expansion
Builder's hardware	R. B. Davies Industries Ak. Ltd.	Expansion
Locks and latches	Legge Pacific Ltd.	New
Furniture castors	Rex Manufacturing Co. Ltd.	Expansion
Worm-drive hose clips	Rex Manufacturing Co. Ltd.	New

FOOTWEAR

Vulcanized footwear	R. Hubrich Ltd.	New
Plastic footwear	Nuon Industries Ltd.	New
Plastic heels	J. Edwards & Son Ltd.	New
Resin rubber solings	Reid N.Z. Rubber Mills Ltd.	New

PETROLEUM AND PETROLEUM BY-PRODUCTS

Bulk bitumen storage	Standard Vacuum Oil Co. (N.Z.) Ltd.	Expansion
Blown bitumen	Emolcum (N.Z.) Ltd.	New
Asphalt	Bitumix Ltd.	Expansion

CHEMICAL MANUFACTURING AND VETINARY PREPARATIONS

Sheep dip and stock remedies	Cooper, McDougall, and Robertson, N.Z. Ltd.	Expansion
Animal vaccines	Cooper McDougall, and Robertson, N.Z. Ltd.	Expansion
P.V.A. emulsions	Polymers (N.Z.) Pty., Ltd.	Expansion

BUILDING MATERIALS

Laminated timber	Hicksons Timber Impregnation Co. (N.Z.) Ltd.	New
Formica Plastic sheet	Formica (N.Z.) Ltd.	New
Vinyl tiles and vinyl extrusions including skirtings, architraves, etc.	The Marley Co. (N.Z.) Ltd.	New
Metal windows	Crittal Metal Windows (N.Z.) Ltd.	Expansion
	L. J. Fisher and Co. Ltd.	Expansion
	Hawksley N.Z. Ltd.	Expansion
Fibre-glass insulating wool	N.Z. Fibre Glass Ltd.	New
Asbestos-cement pipes	Jas. J. Hardie & Co. Ltd.	Expansion

PAPER AND ALLIED PRODUCTS

Woodpulp kraft paper, wallboard	N.Z. Forest Products Ltd.	Expansion
Printed labels	Briginshaw Bros (N.Z.) Ltd.	Expansion
Self-adhesive labels	Raywin Press Ltd.	New
Self-adhesive tape	E. S. and A. Robinson Ltd.	New
Paper tubes : cones	Textile-Cones and Tubes Pty. Ltd.	Expansion
Cardboard, etc., containers and cartons	E. S. and A. Robinson Ltd.	Expansion
Corrugated cardboard	A.C.I. Fibre Packages Pty. Ltd.	Expansion

Conical paper containers	Carton Specialties Ltd.	Expansion
Paper patterns	Simplicity Patterns Ltd.	Expansion
	Butterick Patterns Ltd.	Expansion
FOOD PROCESSING		
Neutral spirit	N.Z. Distillery Co. Ltd.	New
Gin distilling	Distillers Co. of N.Z. Ltd.	New
	Gilby's Ltd.	New
	Seagars N.Z. Ltd.	New
Instant coffee	The Nestele Co. (N.Z.) Ltd.	New
	Coffee Specialists	New
Glucose	Wheat Industries (N.Z.) Ltd.	New
Dextrine	Wheat Industries (N.Z.) Ltd.	New
Wheaten cornflour, dry gluten	Starch Products Ltd. Wheat Industries (N.Z.) Ltd.	Expansion
"Vegemite" yeast extract	Kraft Foods Ltd.	Expansion
Beverages	Grey and Menzies Ltd.	Expansion
Sugar packaging	N.Z. Sugar Co. Ltd.	Expansion
WOOLLEN MILLING		
Woollen piecegoods, blankets and yarns	Holeproof (N.Z.) Ltd.	Expansion
Blankets and rugs	Onehunga Woollen Mills Ltd.	Expansion
GARMENT AND FABRIC KNITTING		
Fully fashioned Knitwear	Holeproof (N.Z.) Ltd.	Expansion
	Wakefield Bros (N.Z.) Ltd.	Expansion
Warp knitted fabric	Manakau Knitting Mills Ltd.	Expansion
CARPET AND RUG MAKING		
Carpets	Tattersfield Ltd.	Expansion
	Bremner and Norrie Ltd.	Expansion
	McKendrick Textiles Ltd.	Expansion
	I.C. Steele (Carpets) Ltd.	Expansion
Haircord and Wilton floor coverings	Wilton Weavers Ltd.	Expansion
HOSIERY KNITTING		
Seamless hosiey	Holeproof (N.Z.) Ltd.	Expansion
Children's hosiery	Holeproof (N.Z.) Ltd.	Expansion
MISCELLANEOUS TEXTILE PRODUCTS		
Slide fasteners	Geo. Pizzey & Sons (N.Z.) Ltd.	Expansion
	Slidefast (N.Z.) Ltd.	Expansion
Woven labels	Woven Labels Ltd.	Expansion
Tufted bedspreads, bath mats etc.	Irish Tapestry Ltd.	Expansion
UNCLASSIFIED PRODUCTS		
Toy construction kits	Rayon Surfaces Ltd.	New
Venetian blind strip (painted)	Hunter Douglas (N.Z.) Ltd.	New
P.V.C. gloves	James North & Sons Ltd.	New
Electronic organs and electric guitars	Beverly Bruce & Goldie Ltd.	New
Electric guitars	Concord Musical Industies	New
Ballpoint pens	Biro Swan and Gollin (N.Z.) Ltd.	New
	D. J. Robertson Ltd .	New

Plastic containers and bubble packs	Vista Pak Ltd.	New
Safety equipment, protective helmets, goggles, welding helmets	Protector Safety Products (N.Z.) Ltd.	New
Colour-film processing	Agfa (N.Z.) Ltd.	New
Cigars	G. Pezaro and Son Ltd.	Expansion
Rods and reels	Owen Eyre Ltd.	New
Reels	Sportex Co. (N.Z.) Ltd.	New
Rods and lures	Tasman Tackle Co. Ltd.	New
Rods	Allan G. Mitchell Ltd.	New

Source: W. B. Sutch: "Programme for Growth," June 1960

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